ECM group

August 29, 2006

Peter Van Alyea
50 Professional Center Drive, Suite 100
Rohnert Park, California 94928

Re: Case Closure Proposal - Former Eureka Bulk Plant
105 X Street, Eureka, California

Dear Mr. Van Alyea:

ECM Group has prepared this closure proposal for the above-referenced site (Figures 1 and 2, Appendix A). A Corrective Action Plan (CAP) was prepared for the site in 2003 which recommended soil excavation as the most cost effective and technologically feasible remedial alternative. Remedial overexcavation was conducted at the site in 2004. Since the excavation, the site has been monitored for six quarters to verify the effectiveness of the remedial action. Fate and transport modeling has been conducted to predict future extent and contaminant concentration in the groundwater plume, and to provide an estimate of time required for natural attenuation to reach the clean-up objectives (Appendix D).

Case closure is appropriate for the following reasons:

1.) The major source of groundwater contamination (contaminated soil) has been removed.

2.) Contaminant levels are decreasing or stable in all site wells.

3.) The only potential sensitive receptor identified near the site is the Eureka Slough, located approximately 700 ft east (downgradient) of the release. Fate and transport modeling indicates the groundwater plume will never reach this receptor.

4.) No complete exposure pathways or potentially complete exposure pathways exist at the site. No water wells are known to be in use. The municipal drinking water supply is sourced from the Mad River. Any future municipal wells could not practically be located east or north of the site due to the presence of the (saltwater) slough.

5.) Through continued natural attenuation and degradation, MCLs will be obtained within decades. There is no justification for continued site monitoring.

6.) The site conditions do not present a potential threat to human health or safety, or to the environment.

In summary, remaining hydrocarbons will continue to degrade with time and case closure is recommended for this site. Site wells should be properly destroyed at this time.

P.O. Box 802, Benicia, CA, 94510<< 707-751-0655>> 707-751-0653 (fax) << ecmgrp@aol.com

Site History

Information regarding site history and past use of the site has been provided by Redwood Oil Company. The facility, located at 105 X Street, in Eureka, California, was used as a bulk storage and distribution facility for fuel and fuel products. Age of the facility is unknown. The facility was purchased by Redwood Oil Company in 1989. In March of 1999, use of the facility as a bulk storage and distribution facility was terminated. The site is currently a trucking dispatch office.

Historically, a number of Above Ground Storage Tanks (ASTs) were located at the facility. Information regarding exact number, size, and type of ASTs used at the site in past decades is not available for this document. In 1999, four ASTs were located at the facility: a diesel AST, an unused 1,000-gallon AST, a 500-gallon AST used to hold "grout oil" (i.e. discarded oil [not used crank-case oil] from various applications such as chainsaw lubricating oil) and a 200-gallon kerosene AST. The diesel AST, the 1,000 gallon unused AST, and the 500-gallon "grout oil" AST were located in the containment area (Figure 3, Appendix A). The location of the kerosene AST is shown on Figure 3 (Appendix A)..

In 1999, soil containing petroleum hydrocarbons was excavated from the site.[1] Excavation limits are shown in Figure 3 (Appendix A). Total depth of the excavation was approximately 2.5 ft below ground surface (bgs). Approximately 40 cubic yards of soil were excavated. Groundwater was observed in the excavation at a depth of approximately 2.5 ft bgs. Five soil samples (labeled 1 through 5) and one water sample (W-1) were collected from the excavation. Analytical results for the soil samples from the excavation are shown in Tables 7 and 8 (Appendix B). Analytical results for the groundwater sample collected from the excavation are shown in Tables 4, 5, and 6 (Appendix B).

On December 21 and 22, 1999, seven temporary soil borings (B-1 through B-7) were installed at the site.[2] Soil and groundwater samples were collected from the borings. Boring locations are shown on Figure 3 (Appendix A). Analytical results for soil are shown in Table 9 (Appendix B), and analytic results for groundwater are shown in Table 4 (Appendix B).

On April 13, 2001, four monitoring wells (MW-1 through MW-4) were installed at the site (Figure 2, Appendix A).[3] Soil and groundwater samples were collected from the wells.

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1 ECM, 1999, Former Eureka Bulk Plant, 105 X Street, Eureka, California, prepared by ECM Group for Redwood Oil Company, August 11, 1999, 5 pages and 3 appendices.

2 ECM, 2000, Subsurface Investigation Report, Former Eureka Bulk Plant, 105 X Street, California, March 7, 2000, 7 pages and 6 appendices.

3 ECM, 2001, Subsurface Investigation Report, Former Eureka Bulk Plant, 105 X Street, Eureka, California, June 15, 2001, 8 pages and 5 appendices.

Analytical results for soil are included in Table 9 (Appendix B). Cumulative analytical results for groundwater are shown in Tables 2 and 3 (Appendix B). Well construction details and cumulative groundwater elevation measurements for all monitoring wells are listed in Table 1 (Appendix B).

On March 4, 2002, one soil boring (B-8) was installed to the north of the site. On December 6, 2002, one soil boring (B-9) was installed to the south of the site (Figure 3, Appendix A).

On January 30, 2003, six temporary soil borings (B-10 through B-15) and two monitoring wells (MW-5 and MW-6) were installed at the site (Figure 3, Appendix A).[4] Well construction details and cumulative groundwater elevation measurements for all monitoring wells are shown in Table 1 (Appendix B). Cumulative analytical results for soil samples are listed in Table 9 (Appendix B). Cumulative analytical results for groundwater are shown in Tables 2 and 3 (Appendix B).

Boring B-8A was installed in the same location as boring B-8 in January 2004 to verify the results of Boring B-8.

In September, 2004, a remedial excavation was conducted to remove heavily impacted soil from the center of the site.[5] Approximately 1,000 cubic yards (CY) of contaminated soil was excavated and removed from the site. Total depth of the excavation was approximately 5 ft bgs. The finished extent of the excavation and soil sampling locations are shown on Figure 3 (Appendix A). Underground piping remaining at the site was removed during the course of the excavation.

Geologic and Topographic Setting

The site is located in the City of Eureka, Humboldt County, California. The topography of the site is relatively flat. The Pacific Ocean (Arcata Bay) is located approximately 0.2 miles north of the site.

Site monitoring wells have been monitored on a quarterly basis since their installation. Direction of groundwater flow has consistently been easterly. Depth to groundwater in the six site wells has varied between approximately 1 and 4 ft bgs. The gradient from the most recent sampling event (May 23, 2006) was calculated to be easterly at 0.006 ft/ft (Figure 3, Appendix A). Boring logs indicate that subsurface formations to a depth of approximately 5 ft bgs consist of low-

4 ECM, 2003, Subsurface Investigation Report, Former Eureka Bulk Plant, 105 X Street, Eureka, California, March 17, 2003, 10 pages and 6 appendices.

5 ECM, 2004, Remedial Overexcavation Report, Former Eureka Bulk Plant, 105 X Street, Eureka, California, December 17, 2004, 10 pages and 5 appendices.

permeability silts and clays. Formations below 5 ft consist of silty sands, with substantial percentages of silt and clay.

The site and surrounding area are shown on Figure 4 (Appendix A). A branch of the Eureka Slough is located approximately 700 ft east (downgradient) of the site. No other receptors or potential receptors have been located in the vicinity of the site. The area to the north of the site is undeveloped wetland. Residential units are located immediately south of the site. Commercial properties are located to the east of the site. The area to the west of the site is mixed residential and commercial.

City of Eureka Public Works staff have confirmed that the municipal water supply is provided by the Mad River, and that no wells are present or planned in the vicinity of the site.[6]

Cleanup Levels

The goal of remedial actions at the site has been cleanup to levels attainable through application of best practicable technology, and cleanup to protective water quality levels. The following goals are listed for this site:

Constituent	Cleanup Goal (ppb)
Gasoline	100
Benzene	1.0
Toluene	150
Ethylbenzene	300
Xylenes	1750
Methyl tertiary butyl Ether (MTBE)	5

Contaminant Concentrations in Groundwater

Historical analytical results for groundwater in monitoring wells are tabulated in Tables 2 and 3 (Appendix B). Trend graphs for gasoline, benzene, and MTBE for all monitoring wells are shown in Graphs 1 through 12 (Appendix C).

[6] Personal communication, 2006, Clay Irby of the City of Eureka to Chris Bramer, ECM Group.

Hydrocarbons as Gasoline and BTEX

Clean-up goals for hydrocarbons as gasoline and BTEX have been attained in all wells except for MW-3 and MW-5, and except for occasional benzene detections in MW-1. Trend graphs indicate a decreasing trend for gasoline in MW-3 and MW-5. The most recent results for gasoline in MW-3 and MW-5 were 730 ppb and 92 ppb, respectively. The most recent results for benzene were < 0.5 ppb (non-detect) in MW-5, and 0.58 ppb (just above the detection limit) in the sample from MW-3. Benzene was reported in MW-1 samples in November 2005 and February 2006. However, the most recent results for well MW-1, from May 2006, were non-detect for benzene.

MTBE

Results for MTBE have consistently been at or near the cleanup goal of 5 ppb in all wells except MW-1. Between February 2002 and February 2005, MTBE concentrations in MW-1 showed an increase during periods with an elevated water table. Since February 2005, the MTBE concentrations reported in MW-1 have generally declined. The most recent result for MTBE in MW-1 (in May 2006) was 7.6 ppb. The MTBE concentration vs. time in MW-1 is shown in Graph 2 (Appendix C), and also includes the groundwater levels in MW-1 vs. time.

Fate and Transport Modeling

Fate and transport modeling was conducted for benzene and MTBE at this site to provide an estimate of time required for natural attenuation to reach the clean-up objectives. The modeling program used was BIOSCREEN, a plume modeling program released by the EPA which simulates remediation through natural attentuation at petroleum fuel release sites.[7] A detailed discussion of modeling assumptions, input parameters, and results is provided in Appendix D. The model results are summarized as follows:

- No significant migration away from the former source zone is predicted for benzene or MTBE. No detectable concentrations of benzene are predicted at a distance of greater than 80 ft from the source.

- No contaminants are predicted at concentrations above the MCLs at a distance more than 80 ft from the former source area.

[7] 1997, EPA, BIOSCREEN Natural Attenuation Decision Support System, User's Manual Version 1.4, July 1997.

- Cleanup goals for MTBE and benzene are expected to be reached after 60 years at a distance of 80 ft or less from the source, and within 130 years for the former source area.

Conclusions

Case closure is appropriate at this site for the following reasons:

1.) The major source of groundwater contamination (contaminated soil) has been removed.

2.) Contaminant levels are stable or decreasing in all site wells.

3.) The only potential sensitive receptor identified near the site is the Eureka Slough, located approximately 700 ft east (downgradient) of the release. Fate and transport modeling indicates the groundwater plume will never reach this receptor.

4.) No complete exposure pathways or potentially complete exposure pathways exist at the site. No water wells are known to be in use. The municipal drinking water supply is sourced from the Mad River. Any future municipal wells could not practically be located east or north of the site due to the presence of the (saltwater) slough.

5.) Through continued natural attenuation and degradation, MCLs will be obtained within decades. There is no justification for continued site monitoring.

6.) The site conditions do not present a potential threat to human health or safety, or to the environment.

In summary, remaining hydrocarbons will continue to degrade with time and case closure is recommended for this site. Site wells should be properly destroyed at this time.

Thank you for the opportunity to provide services for this site. Please call if you have questions or require additional information.

Sincerely,
ECM Group

Chris Bramer
Professional Engineer #C48846

Attachments:

Appendix A - Figures
Appendix B - Tables
Appendix C - Graphs
Appendix D - Fate and Transport Modeling

cc: Ms. Kasey Ashley, RWQCB, North Coast Region

APPENDIX A
FIGURES

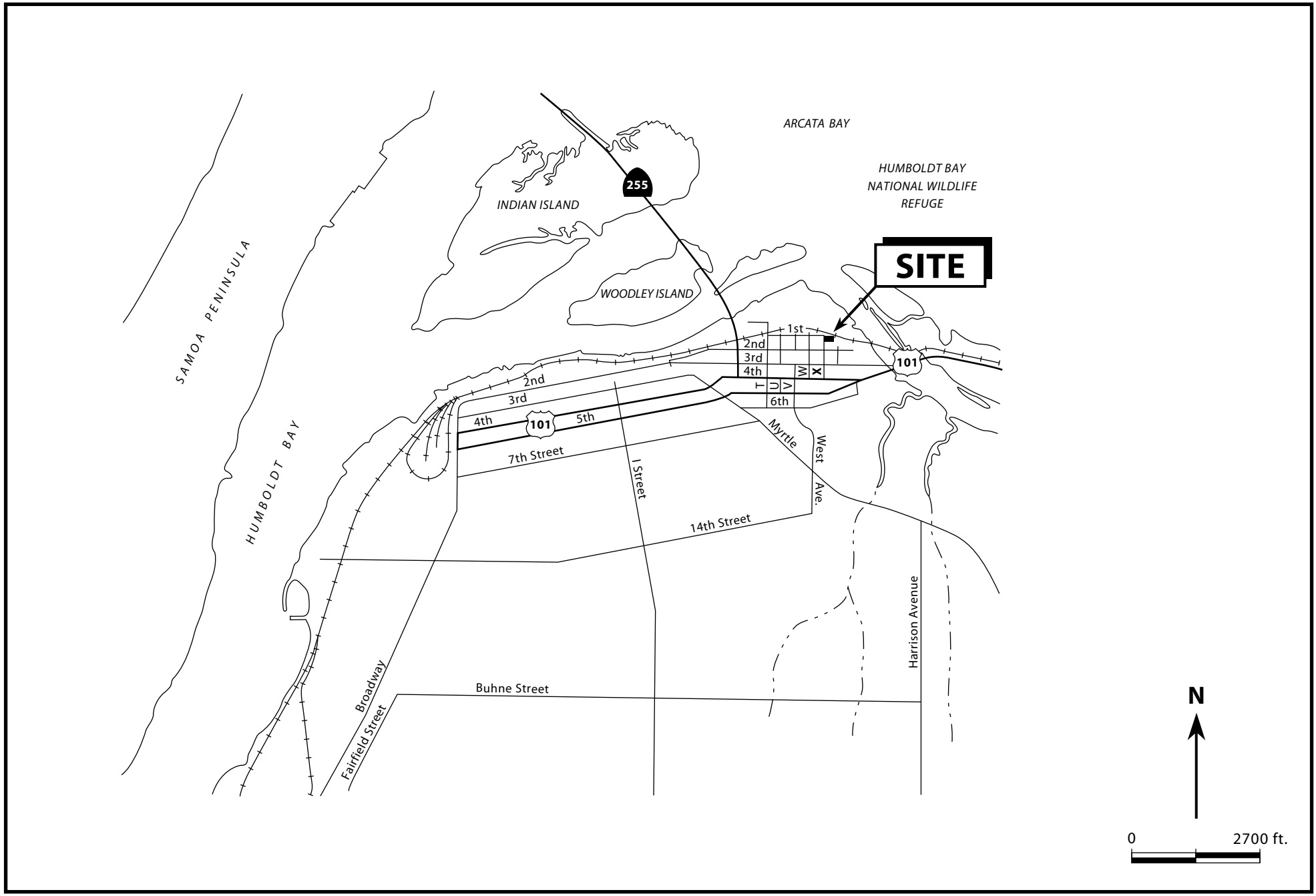


Figure 1. Site Location Map - Former Redwood Oil Bulk Plant, 105 X Street, Eureka, California

EXPLANATION

MW-6	Monitoring well
8.02	Ground water elevation, in feet above mean sea level
[7.87]	Ground water elevation not used in contour
8.00	Ground water elevation contour, dashed where inferred

Approximate ground water flow direction with an approximate gradient of 0.006 ft/ft

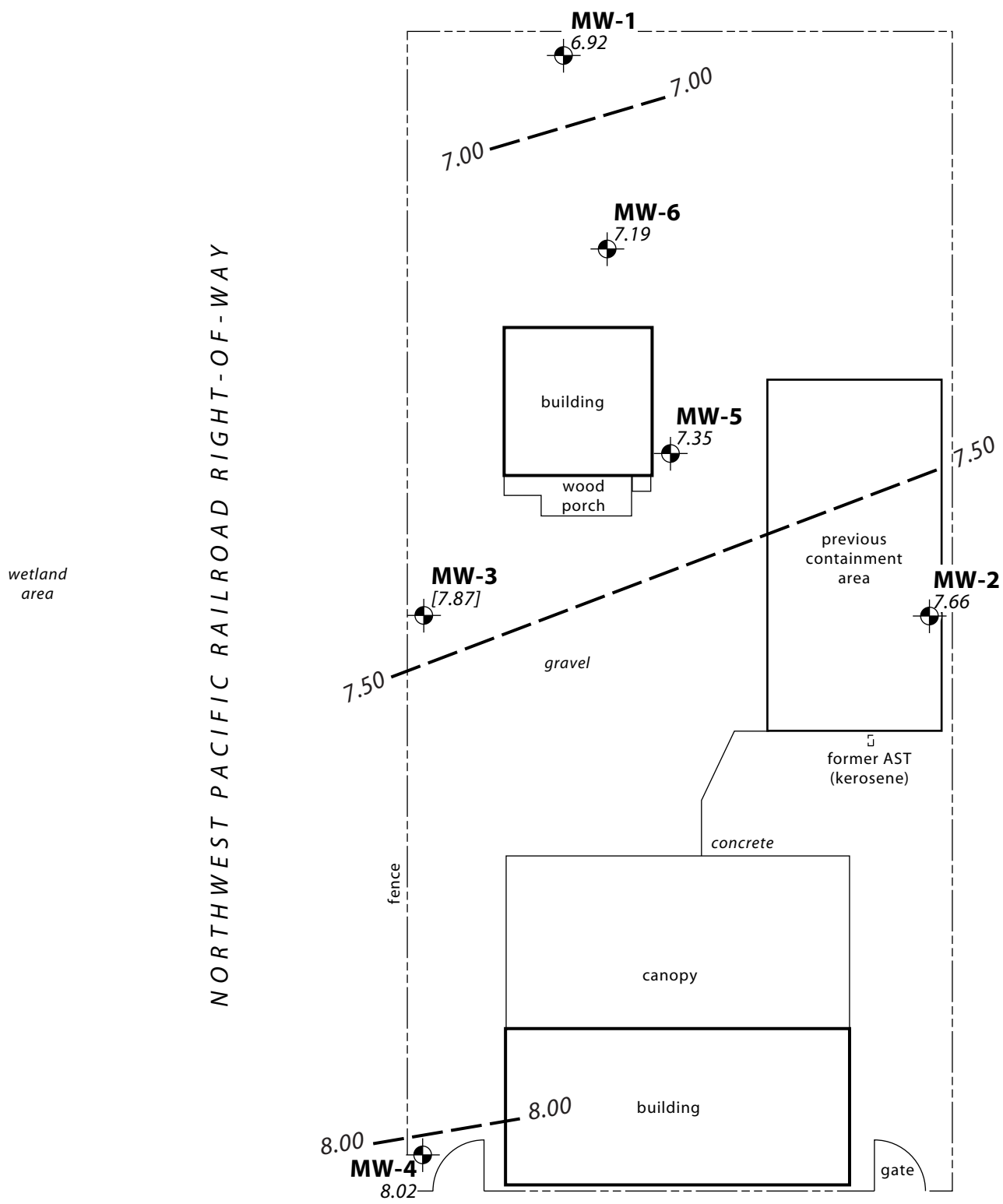


Figure 2. Monitoring Well Location and Groundwater Elevation Contour Map - May 23, 2006 - Former Redwood Oil Bulk Plant, 105 X Street, Eureka, California

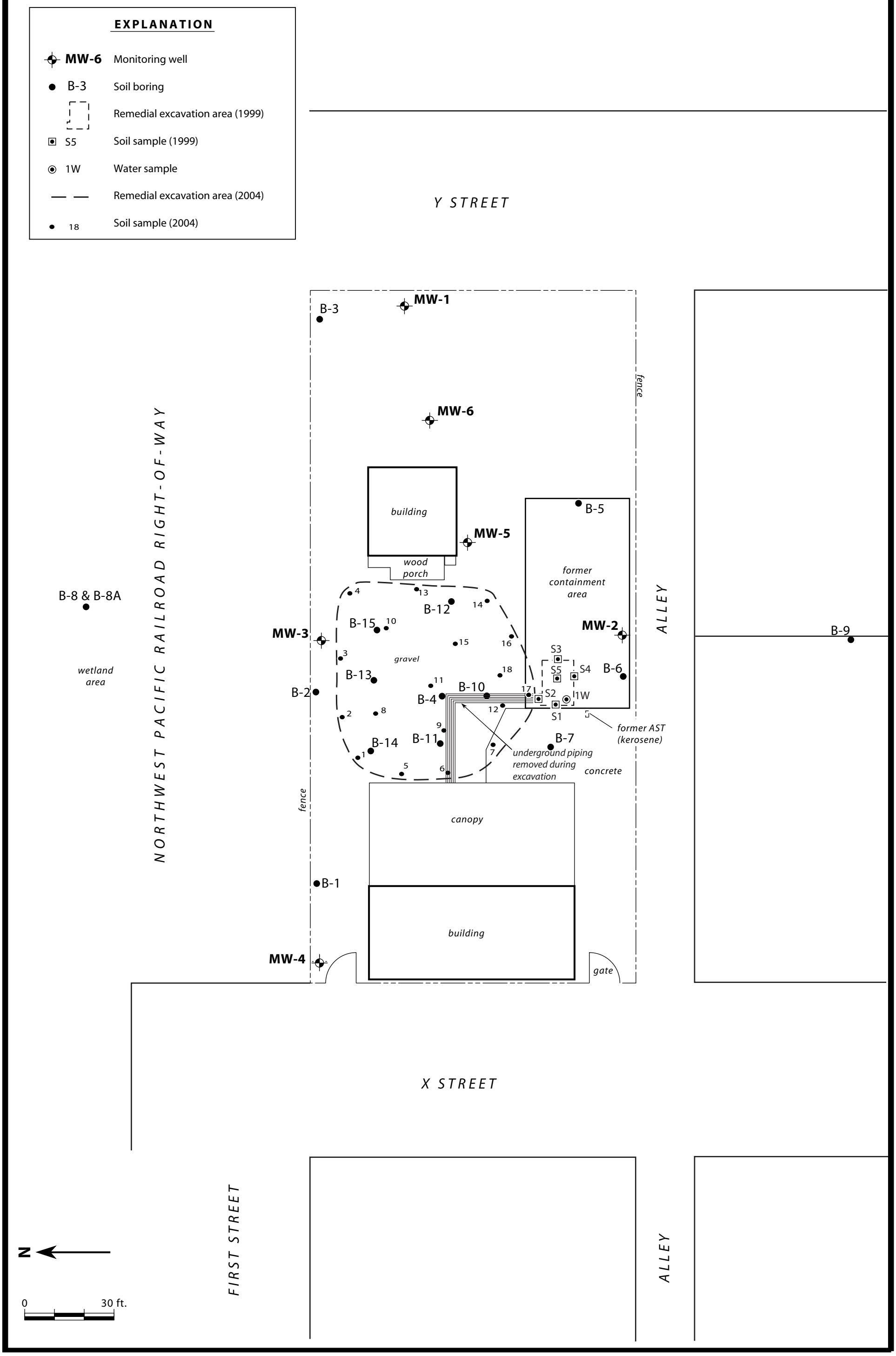


Figure 3. Site Plan - Former Redwood Oil Bulk Plant, 105 X Street, Eureka, California

99-110-34 [site plan] 8/01/06

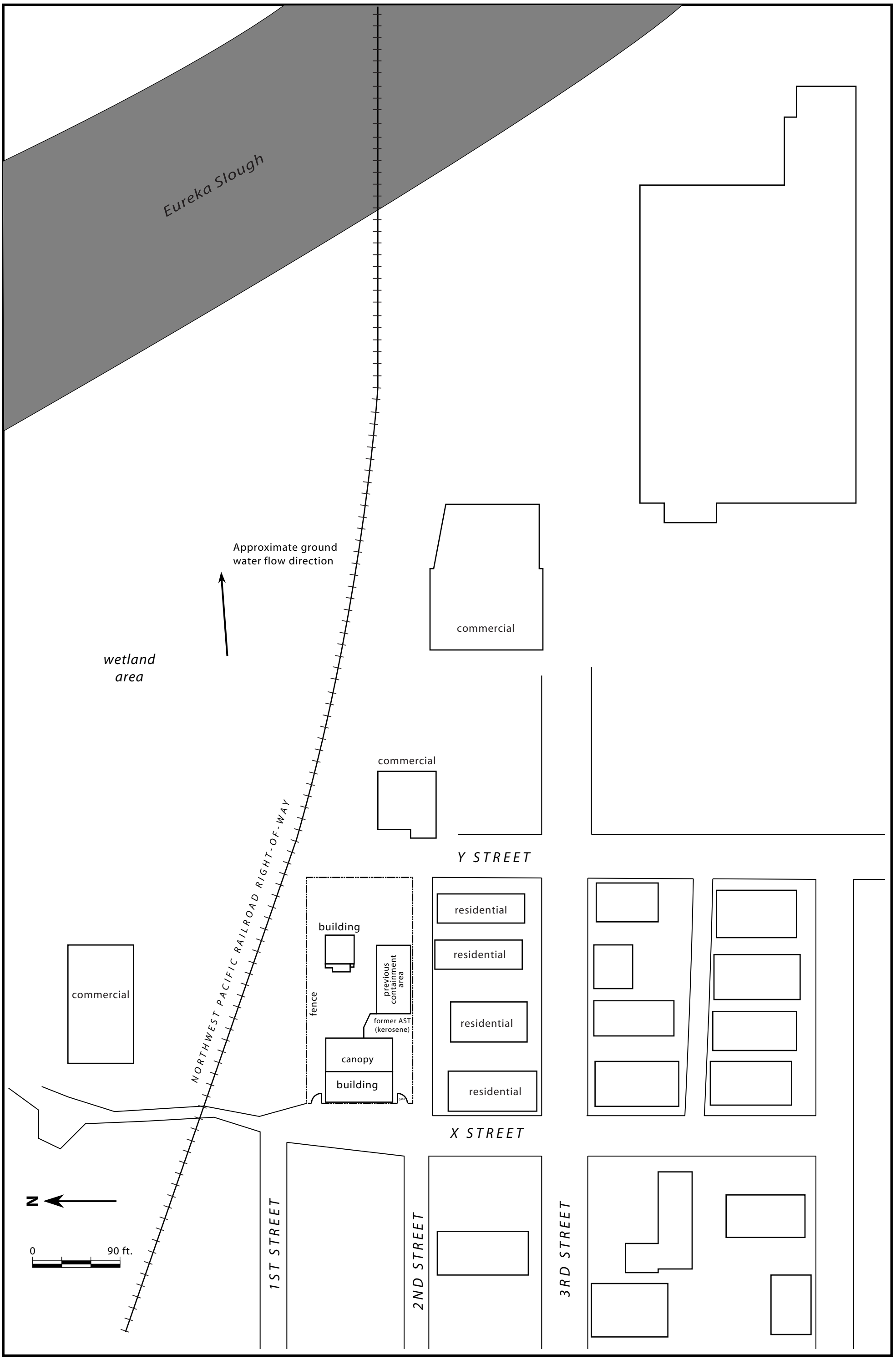


Figure 4.□ Site and Surrounding Area - Former Redwood Oil Bulk Plant, 105 X Street, Eureka, California

APPENDIX B

TABLES

Table 1. Monitoring Well Survey Data, Well Construction Details and Depth to Ground Water - 105 X Street, Eureka, California.

Well ID	Sample Date	DTW (Ft)	TOC (Ft, msl)	GWE (Ft, msl)	Screen Interval	Sand Pack Interval	Bentonite/ Grout Interval	Notes
MW-1	5/14/2001	2.45	9.30	6.85	2 - 12	2 - 12	0 - 2	
	8/13/2001	2.92		6.38				
	11/9/2001	2.63		6.67				
	2/14/2002	1.84		7.46				
	5/1/2002	1.85		7.45				
	8/8/2002	2.91		6.39				
	11/15/2002	2.26		7.04				
	2/14/2003	1.78		7.52				
	5/23/2003	2.14		7.16				
	8/26/2003	2.85		6.45				
	11/17/2003	2.66		6.64				
	2/23/2004	1.38		7.92				
	5/13/2004	2.34		6.96				
	8/17/2004	2.76		6.54				
	11/23/2004	2.17		7.13				
	2/23/2005	1.68		7.62				
	8/17/2005	2.78		6.52				
	11/16/2005	1.46		7.84				
	2/14/2006	1.90		7.40				
	5/23/2006	**2.38**		**6.92**				
MW-2	5/14/2001	3.28	10.96	7.68	2 - 12	2 - 12	0 - 2	
	8/13/2001	3.63		7.33				
	11/9/2001	3.41		7.55				
	2/14/2002	2.90		8.06				
	5/1/2002	2.85		8.11				
	8/8/2002	3.71		7.25				
	11/15/2002	2.92		8.04				
	2/14/2003	2.88		8.08				
	5/23/2003	3.11		7.85				
	8/26/2003	3.65		7.31				
	11/17/2003	3.40		7.56				
	2/23/2004	2.45		8.51				
	5/13/2004	3.28		7.68				
	8/17/2004	3.49		7.47				

Table 1. Monitoring Well Survey Data, Well Construction Details and Depth to Ground Water - 105 X Street, Eureka, California.

Well ID	Sample Date	DTW (Ft)	TOC (Ft, msl)	GWE (Ft, msl)	Screen Interval	Sand Pack Interval	Bentonite/ Grout Interval	Notes
MW-2	11/23/2004	2.99	10.96	7.97	2 - 12	2 - 12	0 - 2	
	2/23/2005	3.86		7.10				
	8/17/2005	3.55		7.41				
	11/16/2005	2.36		8.60				
	2/14/2006	2.84		8.12				
	5/23/2006	**3.30**		**7.66**				
MW-3	5/14/2001	2.81	10.37	7.56	2 - 12	2 - 12	0 - 2	
	8/13/2001	3.29		7.08				
	11/9/2001	2.98		7.39				
	2/14/2002	2.12		8.25				
	5/1/2002	1.99		8.38				
	8/8/2002	3.42		6.95				
	11/15/2002	2.44		7.93				
	2/14/2003	2.11		8.26				
	5/23/2003	2.38		7.99				
	8/26/2003	3.39		6.98				
	11/17/2003	2.60		7.77				
	2/23/2004	1.60		8.77				
	5/13/2004	2.72		7.65				
	8/17/2004	3.19		7.18				
	11/23/2004	2.29		8.08				
	2/23/2005	1.66		8.71				
	8/17/2005	2.96		7.41				
	11/16/2005	1.30		9.07				
	2/14/2006	1.89		8.48				
	5/23/2006	**2.50**		**7.87**				
MW-4	5/14/2001	3.19	11.20	8.01	2 - 12	2 - 12	0 - 2	
	8/13/2001	3.63		7.57				
	11/9/2001	3.39		7.81				
	2/14/2002	2.57		8.63				
	5/1/2002	2.42		8.78				
	8/8/2002	3.89		7.31				
	11/15/2002	3.12		8.08				

Table 1. Monitoring Well Survey Data, Well Construction Details and Depth to Ground Water - 105 X Street, Eureka, California.

Well ID	Sample Date	DTW (Ft)	TOC (Ft, msl)	GWE (Ft, msl)	Screen Interval	Sand Pack Interval	Bentonite/ Grout Interval	Notes
MW-4	2/14/2003	2.58	11.20	8.62	2 - 12	2 - 12	0 - 2	
	5/23/2003	2.88		8.32				
	8/26/2003	3.94		7.26				
	11/17/2003	3.10		8.10				
	2/23/2004	2.19		9.01				
	5/13/2004	3.14		8.06				
	8/17/2004	2.04		9.16				
	11/23/2004	2.93		8.27				
	2/23/2005	2.39		8.81				
	8/17/2005	3.70		7.50				
	11/16/2005	2.05		9.15				
	2/14/2006	2.46		8.74				
	5/23/2006	**3.18**		**8.02**				
MW-5	2/14/2003	2.39	10.26	7.87	2 - 12	2 - 12	0 - 2	
	5/23/2003	2.66		7.60				
	8/26/2003	3.36		6.90				
	11/17/2003	3.09		7.17				
	2/23/2004	1.90		8.36				
	5/13/2004	2.93		7.33				
	8/17/2004	3.25		7.01				
	11/23/2004	2.64		7.62				
	2/23/2005	2.19		8.07				
	8/17/2005	3.33		6.93				
	11/16/2005	1.94		8.32				
	2/14/2006	2.36		7.90				
	5/23/2006	**2.91**		**7.35**				

Table 1. Monitoring Well Survey Data, Well Construction Details and Depth to Ground Water - 105 X Street, Eureka, California.

Well ID	Sample Date	DTW (Ft)	TOC (Ft, msl)	GWE (Ft, msl)	Screen Interval	Sand Pack Interval	Bentonite/ Grout Interval	Notes
MW-6	2/14/2003	2.03	9.69	7.66	2 - 12	2 - 12	0 - 2	
	5/23/2003	2.33		7.36				
	8/26/2003	3.03		6.66				
	11/17/2003	2.81		6.88				
	2/23/2004	1.56		8.13				
	5/13/2004	2.56		7.13				
	8/17/2004	2.96		6.73				
	11/23/2004	2.37		7.32				
	2/23/2005	2.17		7.52				
	8/17/2005	2.86		6.83				
	11/16/2005	1.75		7.94				
	2/14/2006	2.16		7.53				
	5/23/2006	**2.50**		**7.19**				

Explanation:

DTW = Depth to Water msl = Mean Sea Level
ft = feet
TOC = Top of Casing
GWE = Ground Water Elevation

Table 2. Analytical Results for Ground Water - Monitoring Wells - 105 X Street, Eureka, California.

Sample ID	Date Sampled	TPPH (D)	TPPH(MO)	TPPH (G)	Benzene	Toluene	Ethylbenzene	Xylenes	Notes
		<---------- ppb ---------->							
MW-1	5/14/2001	<50	<170	<50	<0.5	<0.5	<0.5	<0.5	
	8/13/2001	<50	<170	<50	<0.5	<0.5	<0.5	<0.5	
	11/9/2001	<50	<170	<50	<0.5	<0.5	<0.5	0.51	
	2/14/2002	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	5/1/2002	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	8/8/2002	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	11/15/2002	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	2/14/2003	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	8/26/2003	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	2/23/2004	<50	<170	130	<0.50	<0.50	<0.50	<0.50	
	8/17/2004	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	2/23/2005	---	---	230	---	---	---	---	Sample flagged by lab. See lab report for details.
	4/21/2005	---	---	130	<1	1.7	<1	2.0	
	8/17/2005	---	---	<50	<0.50	0.67	<0.50	1.0	
	11/16/2005	---	---	86	6.7	4.9	1.3	6.6	
	2/14/2006	---	---	<100	3.0	1.7	<1.0	3.5	
	5/23/2006	**---**	**---**	**<50**	**<0.50**	**<0.50**	**<0.50**	**<0.50**	
MW-2	5/14/2001	190	<170	660	<0.5	<0.5	<0.5	<0.5	
	8/13/2001	140	<170	890	<0.5	<0.5	<0.5	<0.5	
	11/9/2001	<50	<170	300	<0.5	<0.5	<0.5	0.5	
	2/14/2002	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	5/1/2002	<50	<170	180	<0.50	<0.50	<0.50	<0.50	
	8/8/2002	<50	<170	190	<0.50	<0.50	<0.50	<0.50	
	11/15/2002	<50	<170	290	<0.50	<0.50	<0.50	<0.50	
	2/14/2003	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	8/26/2003	<50	<170	140	<0.50	<0.50	<0.50	<0.50	
	2/23/2004	<50	<170	<50	<0.50	<0.50	<0.50	0.5	
	8/17/2004	51	<170	240	<0.50	<0.50	<0.50	<0.50	
	2/23/2005	---	---	<50	---	---	---	---	
	8/17/2005	---	---	83	<0.50	0.51	<0.50	0.99	
	2/14/2006	---	---	<50	<0.50	<0.50	<0.50	<0.50	

Table 2. Analytical Results for Ground Water - Monitoring Wells - 105 X Street, Eureka, California.

Sample ID	Date Sampled	TPPH (D)	TPPH(MO)	TPPH (G)	Benzene	Toluene	Ethylbenzene	Xylenes	Notes
		<---------- ppb ---------->							
MW-3	5/14/2001	930	<170	2,900	28	45	140	69	
	8/13/2001	730	<170	3,600	31	49	140	99	
	11/9/2001	220	<170	2,700	26	39	120	78	
	2/14/2002	660	<170	3,400	20	59	120	82	
	5/1/2002	520	<170	3,600	15	52	150	107	
	8/8/2002	240	<170	1,200	13	17	53	29.7	
	11/15/2002	310	<170	1,900	13	20	64	44.9	
	2/14/2003	730	<170	5,400	31	88	210	112	
	8/26/2003	200	<170	2,000	17	21	67	38.3	
	2/23/2004	360	<170	3,100	21	39	110	62.9	
	8/17/2004	110	<170	1,500	14	11	42	25.9	
	2/23/2005	---	---	1,600	2.8	8.6	69	28	
	8/17/2005	**---**	**---**	350	<0.50	1.0	1.9	3.2	
	11/16/2005	---	---	800	4.1	6.0	17	20	
	2/14/2006	---	---	1,000	1.2	3.9	24	15	
	5/23/2006	**---**	**---**	**730**	**0.58**	**1.5**	**7.7**	**6.1**	
MW-4	5/14/2001	<50	<170	<50	<0.5	<0.5	<0.5	<0.5	
	8/13/2001	<50	<170	<50	<0.5	<0.5	<0.5	<0.5	
	11/9/2001	<50	<170	<50	<0.5	<0.5	<0.5	<0.5	
	2/14/2002	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	5/1/2002	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	8/8/2002	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	11/15/2002	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	2/14/2003	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	8/26/2003	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	2/23/2004	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	8/17/2004	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	2/23/2005	---	---	---	---	---	---	---	MW-4 analyzed for MTBE only, as of 12/2/04.

Table 2. Analytical Results for Ground Water - Monitoring Wells - 105 X Street, Eureka, California.

Sample ID	Date Sampled	TPPH (D)	TPPH(MO)	TPPH (G)	Benzene	Toluene	Ethylbenzene	Xylenes	Notes
		<---------- ppb ---------->							
MW-5	2/14/2003	89	<170	190	<0.50	<0.50	<0.50	<0.50	
	5/23/2003	110	<170	300	<0.50	<0.50	<0.50	<0.50	
	8/26/2003	<50	<170	170	<0.50	<0.50	<0.50	<0.50	
	11/17/2003	51	<170	230	<0.50	<0.50	<0.50	<0.50	
	2/23/2004	94	<170	260	<0.50	<0.50	<0.50	<0.50	
	5/13/2004	62	<170	170	<0.50	<0.50	<0.05	<0.50	
	8/17/2004	62	<170	190	<0.50	<0.50	<0.50	<0.50	
	11/23/2004	460	---	200	<0.5	<0.5	<0.5	<1	
	2/23/2005	---	---	320	---	---	---	---	Sample was flagged. See lab report for details.
	8/17/2005	**---**	**---**	120	<0.50	<0.50	<0.50	0.93	
	11/16/2005	---	---	65	2.8	3.1	1.2	5.3	
	2/14/2006	---	---	110	<0.50	<0.50	<0.50	<0.50	
	5/23/2006	**---**	**---**	**92**	**<0.50**	**<0.50**	**<0.50**	**<0.50**	
MW-6	2/14/2003	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	5/23/2003	<50	<170	58	<0.50	<0.50	<0.50	<0.50	
	8/26/2003	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	11/17/2003	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	2/23/2004	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	5/13/2004	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	8/17/2004	<50	<170	<50	<0.50	<0.50	<0.50	<0.50	
	11/23/2004	<50	---	25	<0.5	<0.5	<0.5	<1	
	2/23/2005	---	---	---	---	---	---	---	MW-6 analyzed for MTBE only, as of 12/2/04.

Explanation:

TPH(D) = Total Petroleum Hydrocarbons as Diesel
TPH(MO) = Total Petroleum Hydrocarbons as Motor Oil
TPH(G) = Total Petroleum Hydrocarbons as Gasoline
ppb = parts per billion

Table 3. Analytical Results for Ground Water - Oxygenates - 105 X Street, Eureka, California.

Sample ID	Sample Date	t-Butyl alcohol (TBA)	MTBE	Diisopropyl ether (DIPE)	Ethyl t-butyl ether (ETBE)	t-Amyl methyl ether (TAME)	Notes
MW-1	5/14/2001	<10.0	3.9	<1.0	<1.0	<1.0	
	8/13/2001	<20	11	<1.0	<1.0	<1.0	
	11/9/2001	<20	14	<1.0	<1.0	<1.0	
	2/14/2002	<20	3.3	<1.0	<1.0	<1.0	
	5/1/2002	<20	3	<1.0	<1.0	<1.0	
	8/8/2002	<20	14	<1.0	<1.0	<1.0	
	11/15/2002	<20	3.8	<1.0	<1.0	<1.0	
	2/14/2003	<20	48	<1.0	<1.0	8.4	
	8/26/2003	<20	12	<1.0	<1.0	<1.0	
	2/23/2004	<10	76	<1.0	<1.0	42	
	8/17/2004	<10	8.1	<1.0	<1.0	<1.0	
	2/23/2005	---	220	---	---	---	
	4/21/2005	---	110	---	---	---	
	8/17/2005	---	8.1	---	---	---	
	11/16/2005	---	95	---	---	---	
	2/14/2006	---	100	---	---	---	
	5/23/2006	---	**7.6**	---	---	---	
MW-2	5/14/2001	16	73	<1.0	<1.0	<1.0	
	8/13/2001	<20	130	<1.0	<1.0	1.2	
	11/9/2001	<20	98	<1.0	<1.0	<1.0	
	2/14/2002	<20	12	<1.0	<1.0	<1.0	
	5/1/2002	22	120	<1.0	<1.0	<1.0	
	8/8/2002	<20	53	<1.0	<1.0	<1.0	
	11/15/2002	<20	29	<1.0	<1.0	<1.0	
	2/14/2003	<20	36	<1.0	<1.0	<1.0	
	8/26/2003	<20	21	<1.0	<1.0	<1.0	
	2/23/2004	<10	<1.0	<1.0	<1.0	<1.0	
	8/17/2004	<10	9.2	<1.0	<1.0	<1.0	
	2/23/2005	---	16	---	---	---	
	8/17/2005	---	19	---	---	---	
	2/14/2006	---	<1.0	---	---	---	

Table 3. Analytical Results for Ground Water - Oxygenates - 105 X Street, Eureka, California.

Sample ID	Sample Date	t-Butyl alcohol (TBA)	MTBE	Diisopropyl ether (DIPE)	Ethyl t-butyl ether (ETBE)	t-Amyl methyl ether (TAME)	Notes
MW-3	5/14/2001	<50	8.1	<2.5	<2.5	<2.5	
	8/13/2001	<20	<20	<1.0	<1.0	<1.0	
	11/9/2001	<20	<20	<1.0	<1.0	<1.0	
	2/14/2002	<20	4.9	<1.0	<1.0	<1.0	
	5/1/2002	<20	4.4	<1.0	<1.0	<1.0	
	8/8/2002	<20	6.3	<10	<1.0	1.4	
	11/15/2002	<20	6.1	<1.0	<1.0	<3.0	
	2/14/2003	<20	<12	<1.0	<1.0	<1.0	
	8/26/2003	<20	<10	<1.0	<1.0	1.2	
	2/23/2004	<10	<6.0	<1.0	<1.0	<1.0	
	8/17/2004	<10	<8.0	<1.0	<1.0	<1.0	
	2/23/2005	---	6.0	---	---	---	
	8/17/2005	---	3.1	---	---	---	
	11/16/2005	---	7.9	---	---	---	
	2/14/2006	---	7.8	---	---	---	
	5/23/2006	---	**2.8**	---	---	---	
MW-4	5/14/2001	<10.0	<0.50	<1.0	<1.0	<1.0	
	8/13/2001	<20	<1.0	<1.0	<1.0	<1.0	
	11/9/2001	<20	<1.0	<1.0	<1.0	<1.0	
	2/14/2002	<20	<1.0	<1.0	<1.0	<1.0	
	5/1/2002	<20	<1.0	<1.0	<1.0	<1.0	
	8/8/2002	<20	5.9	<1.0	<1.0	<1.0	
	11/15/2002	<20	4.7	<1.0	<1.0	<1.0	
	2/14/2003	<20	8.8	<1.0	<1.0	<1.0	
	8/26/2003	<20	6.9	<1.0	<1.0	<1.0	
	2/23/2004	<10	6.7	<1.0	<1.0	<1.0	
	8/17/2004	<10	4	<1.0	<1.0	<1.0	
	2/23/2005	---	3.1	---	---	---	
	2/14/2006	---	2.3	---	---	---	

Table 3. Analytical Results for Ground Water - Oxygenates - 105 X Street, Eureka, California.

Sample ID	Sample Date	t-Butyl alcohol (TBA)	MTBE	Diisopropyl ether (DIPE)	Ethyl t-butyl ether (ETBE)	t-Amyl methyl ether (TAME)	Notes
MW-5	2/14/2003	<20	32	<1.0	<1.0	<1.0	
	5/23/2003	<20	52	<1.0	<1.0	1	
	8/26/2003	<20	43	<1.0	<1.0	<1.0	
	11/17/2003	<20	57	<1.0	<1.0	1.6	
	2/23/2004	<10	20	<1.0	<1.0	<1.0	
	5/13/2004	<10	22	<1.0	<1.0	<1.0	
	8/17/2004	<10	55	<1.0	<1.0	2.6	
	11/23/2004	<10	33	<5	<5	<5	
	2/23/2005	---	8.8	---	---	---	
	8/17/2005	---	3.1	---	---	---	
	11/16/2005	---	2.2	---	---	---	
	2/14/2006	---	3.9	---	---	---	
	5/23/2006	---	**1.1**	---	---	---	
MW-6	2/14/2003	<20	10	<1.0	<1.0	<1.0	
	5/23/2003	<20	41	<1.0	<1.0	1.7	
	8/26/2003	<20	25	<1.0	<1.0	<1.0	
	11/17/2003	<20	25	<1.0	<1.0	<1.0	
	2/23/2004	<10	5.3	<1.0	<1.0	<1.0	
	5/13/2004	<10	15	<1.0	<1.0	<1.0	
	8/17/2004	<10	25	<1.0	<1.0	<1.0	
	11/23/2004	<10	19	<5	<5	<5	
	2/23/2005	---	9.8	---	---	---	
	8/17/2005	---	11	---	---	---	
	11/16/2005	---	9.2	---	---	---	
	2/14/2006	---	2.4	---	---	---	
	5/23/2006	---	**1.2**	---	---	---	

Explanation:

MTBE = Methyl Tertiary-butyl Ether

Table 4. Analytical Results for Ground Water (Borings and Excavation) - Former Redwood Oil Bulk Plant, 105 X Street, Eureka, California

Sample ID	Sample Date	TPH-G	TPH-D	TPH-MO	Benzene	Toluene	Ethyl-Benzene	Xylenes	MTBE	VOCs
		<---------- ppb ---------->								
W-1	6/24/99	19,000	2,000	870	<1.0	<1.0	<1.0	<1.0		
B-1	12/21/99	<50	570	<50	<0.5	<0.5	<0.5	<0.5	<2.0[1]	ND[4]
B-2	12/21/99	6,800	2,900	16,000	2.9	35	48	93	<2.0[1]	71[5]
B-3	12/21/99	<50	<50	1,600	<0.5	<0.5	<0.5	<0.5	<2.0[1]	ND[4]
B-4	12/21/99	34,000	590,000	<50	11	30	88	410	140[2]	15[5]
B-5	12/21/99	<50	<50	<50	<0.5	<0.5	<0.5	<0.5	<2.0[1]	ND[4]
B-6	12/21/99	<50	<50	<50	<0.5	0.5	<0.5	<0.5	<2.0[1]	ND[4]
B-7	12/22/99	5,400	9,400	<50	<0.5	8.2	33	66	580[3]	3.5[7]
B-8	3/4/02	<50	810[8]	1,200[9]	<0.5	<0.5	<0.5	<0.5	<5	---
B-9	12/6/02	<50	<50	<170	<0.50	<0.50	<0.50	<0.50	3.9	---
B-10@4'	1/30/03	550	6,700	210	<0.50	<0.50	<0.50	<0.50	230[10]	---
B-10@30'	1/30/03	69	130	<170	<0.50	<0.50	<0.50	<0.50	5.5[10]	---
B-11	1/30/03	1,600	2,600,000	250,000	54	5.1	<1.0	<1.0	87[11]	---
B-12	1/30/03	670	43,000	900	<1.0	<1.0	<1.0	<1.0	87[11]	---
B-13	1/30/03	7,000	400,000	10,000	43	9.5	27	11.4	<30[11]	---
B-14	1/30/03	890	550,000	11,000	<1.0	<1.0	<1.0	<1.0	8.2[11]	---
B-15	1/30/03	9,400	82,000	3,000	49	18	88	53.6	<30[11]	---
B-8A[13]	1/24/04	<50	<50	<250	<1	<1	<1	<1	<1[11]	---

Table 4. Analytical Results for Ground Water (Borings and Excavation) - Former Redwood Oil Bulk Plant, 105 X Street, Eureka, California

Explanation:

TPH-G - Total Petroleum Hydrocarbons as Gasoline
TPH-D - Total Petroleum Hydrocarbons as Diesel
TPH-MO- Total Petroleum Hydrocarbons as Motor Oil
MTBE - Methyl-tert-butyl-ether
VOCs - Volatile Organic Compounds
PPB - Parts per Billion

Notes:

[1] Sample analyzed for fuel oxygenates including MTBE by EPA method 8260. Other oxygenates not detected at detection limits from 2.0 to 10 ppb.

[2] Sample analyzed for fuel oxygenates including MTBE by EPA method 8260. Other oxygenates not detected at detection limits from 40 to 200 ppb.

[3] Sample analyzed for fuel oxygenates including MTBE by EPA method 8260. Tertiary Butanol detected at 100 ppb. Other oxygenates not detected at detection limits from 20 to 100 ppb.

[4] VOCs analyzed by EPA method 8260B. Detection limit of 2.0 ppb.

[5] 1,2,4-trimethylbenzene detected at 71 ppb. Also detected in sample: Toluene 3.7 ppb; Ethylbenzene 29 ppb; m/p-xylene 59 ppb; o-xylene 15 ppb; Isopropylbenzene 10 ppb; n-propylbenzene 24 ppb; tert-butylbenzene 8.2 ppb; p-isopropyltoluene 9.1 ppb; n-butylbenzene 9.5 ppb; 1,2,4-trichlorobenzene 5.6 ppb; Napthalene 22 ppb; Hexachlorobutadiene 2.6 ppb; 1,2,3-trichlorobenzene 6.9 ppb.

[6] 1,2,,3-trichlorobenzene detected at 15 ppb. Also detected in sample: Toluene 2.0 ppb; Chlorobenzene 2.5 ppb; Isopropoyl benzene 9.5 ppb; n-propylbenzene 8.1 ppb; sec-butylbenzene 14 ppb; n-butylbenzene 9.6 ppb; 1,2,4-trichlorobenzene 4.1 ppb.

[7] Sec-butylbenzene detected at 3.5ppb. No other VOCs detected in sample at detection limits from 2.0 to 7.1 ppb. Detection limit 2.0ppb.

[8] Reported TPH as Diesel value is a result of heavy hydrocarbons in the hydraulic oil range carrying into the TPH as Diesel quantitation range.

[9] While TPH as Motor Oil is present, a second fuel carrying over from the TPH as hydraulic oil range in the the TPH as Motor Oil range, has resulted in an elevated final TPH as Motor Oil result.

[10] Sample analyzed for fuel oxygenates including MTBE by EPA method 8260. TBA was detected at 120 ppb and at 38 ppb in the samples collected from B10@4' and B10@30', respectively. TAME was detected at 5.9 ppb in B10@4'.

[11] Sample analyzed for fuel oxygenates including MTBE by EPA method 8260. No other oxygenates were detected.

[12] Reported TPH as diesel value is a result of heavy hydrocarbons in the hydraulic oil range carrying into the TPH as Diesel quantitation range. A second fuel carrying over from the TPH as hydraulic oil range into the TPH as Motor Oil range, has resulted in an elevated final TPH as Motor Oil result.

Table 5. Analytical Results for Water (Excavation) - EPA Method 8260B, EPA Method 8080 for PCBs, and EPA Method 8270 for PNAs - Former Redwood Oil Bulk Plant - 105 X Street, Eureka, California

Sample ID	Sample Date	Isopropyl Benzene[1]	n-propylbenzene[1]	sec-Butylbenzene[1]	p-Isopropyltoluene[1]	n - Butylbenzene[1]	Napthalene[1]	EPA Method 8080 PCBs	EPA Method 8270 PNAs
		< ---------- PPB ---------- >							
W-1	6/24/99	8.5	18	23	2.0	19	2.4	ND[2]	ND

Explanation:

PPB - Parts Per Billion
PCBs - Poly Chlorinated Biphenyls
PNAs - Poly Nuclear Aromatic Hydrocarbons

Notes:

[1] Analyzed by EPA method 8260B for volatile organic compounds. No other analytes were detected at a detection limit of 1.0 ppb.
[2] No analytes detected at detection limits between 0.05 and 5 ppb.

Sample ID	Sample Date	MTBE	DIPE	ETBE	TAME	TBUT
		<---------- PPB ---------->				
W-1	6/24/99	590	<1.0	<1.0	2.6	500

Explanation:

MTBE - Methyl-t-butyl ether
DIPE - Diisopropyl ether
ETBE - Ethyl-t-butyl ether
TAME - Tert-amyl methyl ether
TBUT - Tert-Butanol

C1:\ECMprojects\110\GWT5-excavation-MTBE

Table 6. Analytical Results for Water (Excavation) - Metals - Former Redwood Oil Bulk Plant - 105 X Street, Eureka, Califomia

Sample ID	Sample Date	Cd	Cr	Pb	Ni	Zn
		<---------- PPM ---------->				
W-1	6/24/99	0.047	0.013	<0.015	<0.005	0.039

Explanation:

Cd - Cadmium
Cr - Chromium
Pb - Lead
Ni - Nickel
Zn - Zinc
PPM - Parts Per Million

C:\ECMprojects\110\GW T6 - excavation - metals

Table 7. Analytical Results for Soil (Excavation) - Former Redwood Oil Bulk Plant - 105 X Street, Eureka, California

Sample ID	Sample Date	Sample Depth (in feet)	TPH-G	TPH-D	TPH-MO	B	T	E	X	MTBE
			<---------- PPM ---------->							
1	6/24/99	1.5	<1.0	4.1	58	<0.005	0.0069	<0.005	0.010	0.016[1]
2	6/24/99	1.5	94	3,800	2,800	<0.005	<0.005	<0.005	0.041	0.050
3	6/24/99	1.5	<1.0	<1.0	450	<0.005	<0.005	<0.005	<0.005	<0.005[2]
4	6/24/99	1.5	2.2	1,700	400	<0.005	<0.005	<0.005	<0.005	0.013[2]
5	6/24/99	2.5	1.0	24	140	<0.005	<0.005	<0.005	<0.005	0.12

Explanation:

TPH-G - Total Petroleum Hydrocarbons as Gasoline
TPH-D - Total Petroleum Hydrocarbons as Diesel
TPH-MO - Total Petroleum Hydrocarbons as Motor Oil
B - Benzene
T - Toluene
E - Ethyl benzene
X - Xylenes
MTBE - Methyl-t-butyl ether
PPM - Parts Per Million

Notes:

[1] Analyzed by EPA Method 8260 for fuel oxygenates. Tert-Butanol was also detected at 0.13 ppm. No other fuel oxygenates were detected.
[2] Analyzed by EPA Method 8260 for fuel oxygenates. No other fuel oxygenates were detected at a detection limit of 0.005 ppm.

Table 8. Analytical Results for Soil (Excavation) - Metals, EPA Method 8260B, EPA Method 8080 for PCBs, and EPA Method 8270 for PNAs - Former Redwood Oil Bulk Plant - 105 X Street, Eureka, Califomia

Sample ID	Sample Date	Sample Depth (in feet)	Cd	Cr	Pb	Ni	Zn	EPA 8260B VOCs	EPA 8080A PCBs	EPA 8270 PNAs
			<---------- PPM ---------->						<-------- PPB -------->	
1	6/24/99	1.5	<5.0	21	9.5	11	13	ND[1]	ND	ND
3	6/24/99	1.5	<5.0	27	14	12	18	ND	ND	ND
4	6/24/99	1.5	<5.0	32	8.8	13	17	ND	ND	ND

Explanation:

Cd - Cadmium
Cr - Chromium
Pb - Lead
Ni - Nickel
Zn - zinc
PPM - Parts Per Million
PPB - Parts Per Billion
VOCs - Volatile Organic Compounds
PCBs - Poly Chlorinated Biphenyls
PNAs - Poly Nuclear Aromatic Hydrocarbons

Notes:

[1] Analyzed by EPA Method 8260 for volatile organic coompounds. Toluene detected at 0.0069 ppm. P,M-Xylene detected at 0.0070 ppm.

Table 9. Analytical Results for Soil (Borings and Monitoring Wells) - Former Redwood Oil Bulk Plant, 105 X Street, Eureka, California

Sample ID	Sample Date	Sample Depth (in feet)	TPH-G	TPH-D	TPH-MO	Benzene	Toluene	Ethyl-Benzene	Xylenes	MTBE
			<---------- ppm ---------->							
B-1	12/21/99	2'	<1.0	<1.0	<50	<0.005	<0.005	<0.005	<0.005	---
B-2	12/21/99	2'	<1.0	<1.0	340	<0.005	<0.005	<0.005	<0.005	---
B-3	12/21/99	1'	<1.0	<1.0	560	<0.005	<0.005	<0.005	<0.005	---
B-4	12/21/99	2'	640	400	<50	0.14	0.98	2.2	9.6	---
B-5	12/21/99	2'	<1.0	<1.0	<50	<0.005	<0.005	<0.005	<0.005	---
B-6	12/21/99	1'	<1.0	<1.0	250	<0.005	<0.005	<0.005	<0.005	---
B-7	12/22/99	3'	1.6	<1.0	<50	<0.005	<0.005	0.007	0.02	---
B-8[1,3]	3/4/02	1'	<1.0	54	82	0.031	0.039	0.040	0.080	<0.005
MW-1	4/13/01	3'	<1.0	<1.0	<13.0	<0.005	<0.005	<0.005	<0.005	<0.05
MW-2	4/13/01	4'	<1.0	<1.0	<13.0	<0.005	<0.005	<0.005	<0/005	<0.05
MW-3	4/13/01	4'	83.0	110	<65.0	0.066	0.10	0.25	0.65	<0.5
MW-3	4/13/01	8'	<1.0	7.7	<13.0	<0.005	<0.005	<0.005	<0.005	<0.05
MW-3	4/13/01	10'	1.0	2.0	<13.0	<0.005	<0.005	<0.005	<0.005	<0.05
MW-4	4/13/01	3'	<1.0	2.0	<13.0	<0.005	<0.005	<0.005	<0.005	<0.05
B-9[1]	12/6/02	5'	<1.0	<1.0	<10	<0.0050	<0.0050	<0.0050	<0.0050	<0.25
B-102	1/30/03	3'	110	59	<10	<0.050	<0.050	<1.0	<0.75	<0.5
B-11	1/30/03	3'	410	490	51	<0.25	<0.25	<3.0	<5.0	<2.5
B-12	1/30/03	3'	480	1,300	15	<0.25	<0.25	<3.0	<2.0	<2.5

Table 9. Analytical Results for Soil (Borings and Monitoring Wells) - Former Redwood Oil Bulk Plant, 105 X Street, Eureka, California

Sample ID	Sample Date	Sample Depth (in feet)	TPH-G	TPH-D	TPH-MO	Benzene	Toluene	Ethyl-Benzene	Xylenes	MTBE
			<---------- ppm ---------->							
B-13	1/30/03	3'	1,500	290	<10	<2.0	<10	<12	<19	<0.5
B-14	1/30/03	3'	290	370	<10	<0.050	<0.30	<3.0	<4.0	<0.5
B-15	1/30/03	3'	1,200	310	<10	<1.5	<10	<10	<15	<5.0
MW-5	1/30/03	3'	25	<1.0	<10	<0.0050	<0.10	<0.80	0.027	<0.05
		6'	2.2	2.7	58	<0.0050	<0.010	<0.050	<0.030	<0.05
		12'	<1.0	<1.0	<10	<0.0050	<0.0050	<0.0050	<0.0050	<0.05
MW-6	1/30/03	2.5'	<1.0	<1.0	<10	<0.0050	<0.0050	<0.0050	<0.0050	<0.05
		6'	<1.0	<1.0	<10	<0.0050	<0.0050	<0.0050	<0.0050	<0.05
		12'	<1.0	<1.0	<10	<0.0050	<0.0050	<0.0050	<0.0050	<0.05
B-8A[1]	1/24/04	1'	<1	23[4]	52[4]	<0.005	<0.005	<0.005	<0.005	<0.005
B-8A[5]	1/24/04	1'	---	<10	<50	—	—	—	---	---

Table 9. Analytical Results for Soil (Borings and Monitoring Wells) - Former Redwood Oil Bulk Plant, 105 X Street, Eureka, California

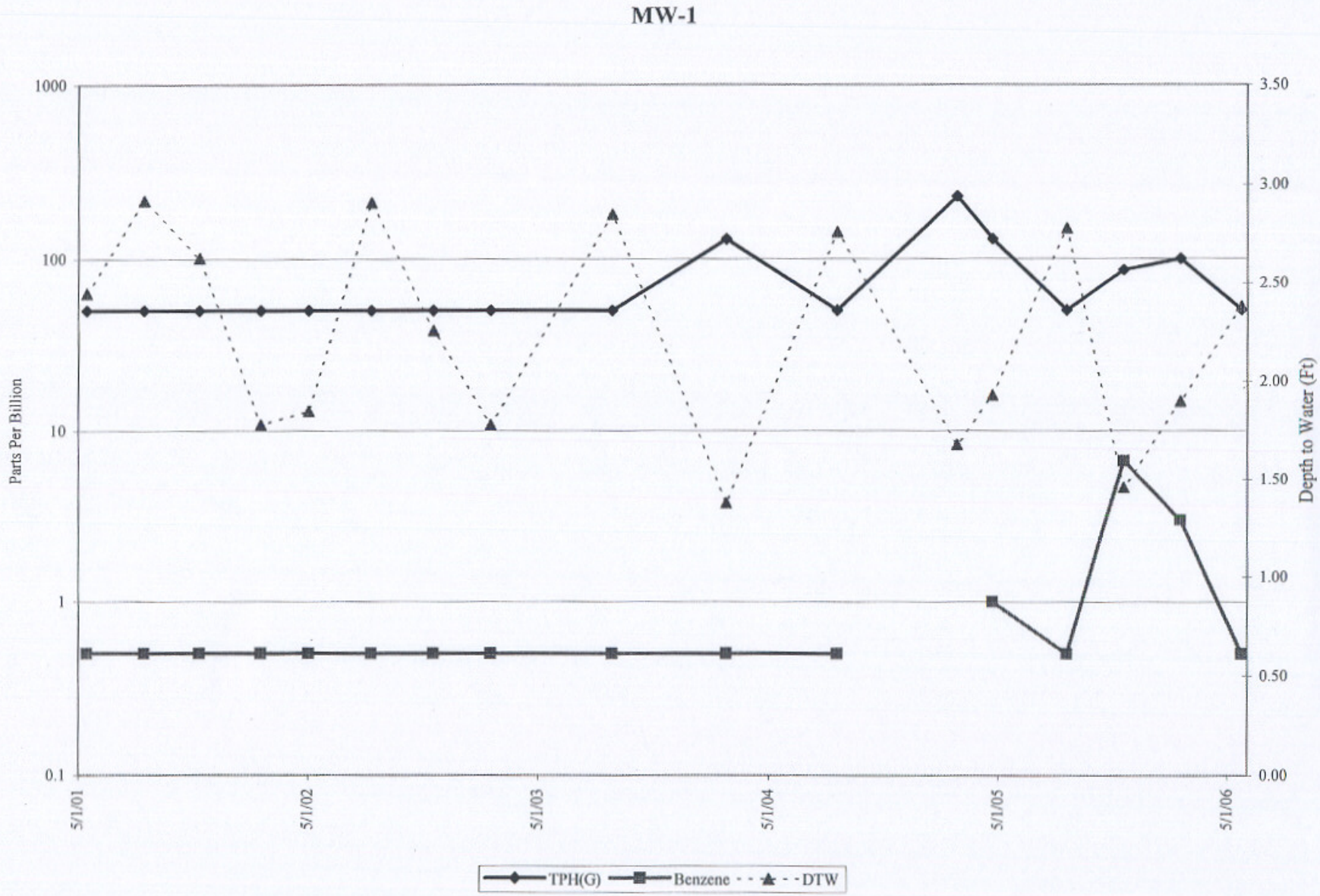
Explanation:

TPH-G - Total Petroleum Hydrocarbons as Gasoline
TPH-D - Total Petroleum Hydrocarbons as Diesel
TPH-MO - Total Petroleum Hydrocarbons as Motor Oil
PPM - Parts per Million

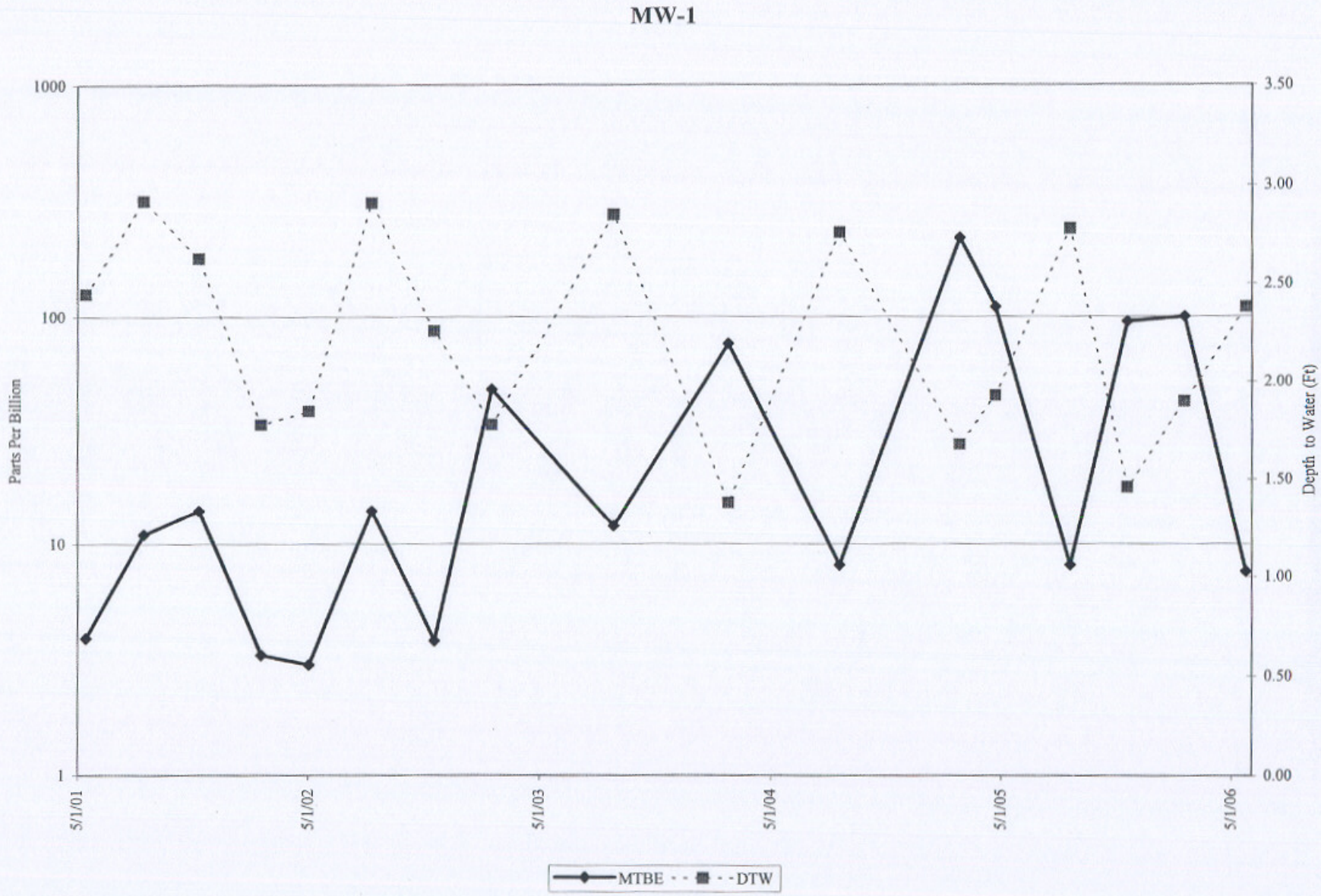
Notes:

[1] Sample also analyzed for fuel oxygenates. No oxygenates were detected.
[2] Sample also analyzed for MTBE. MTBE was not detected. See analytical report for detection limits.
[3] Reported TPH as Diesel value is the result of carry over from the motor range into the TPH as diesel range.
[4] The pattern of peaks present is not indicative of a petroleum product. Biogenic material appears to be present.
[5] Sample B-8A was re-analyzed using EPA Method 8015M, with sample extracts passed through a silica gel column prior to analysis.

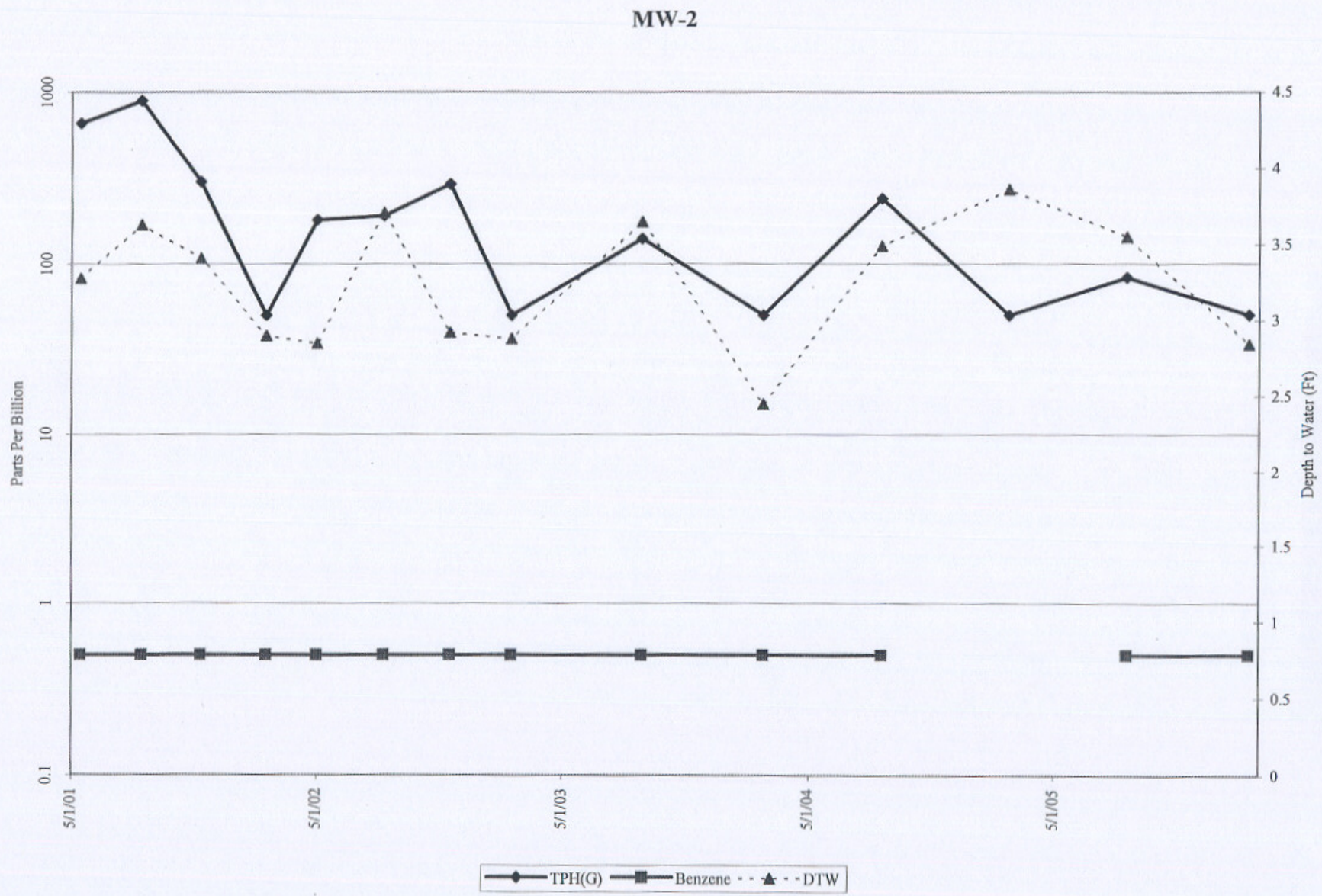
APPENDIX C
GRAPHS



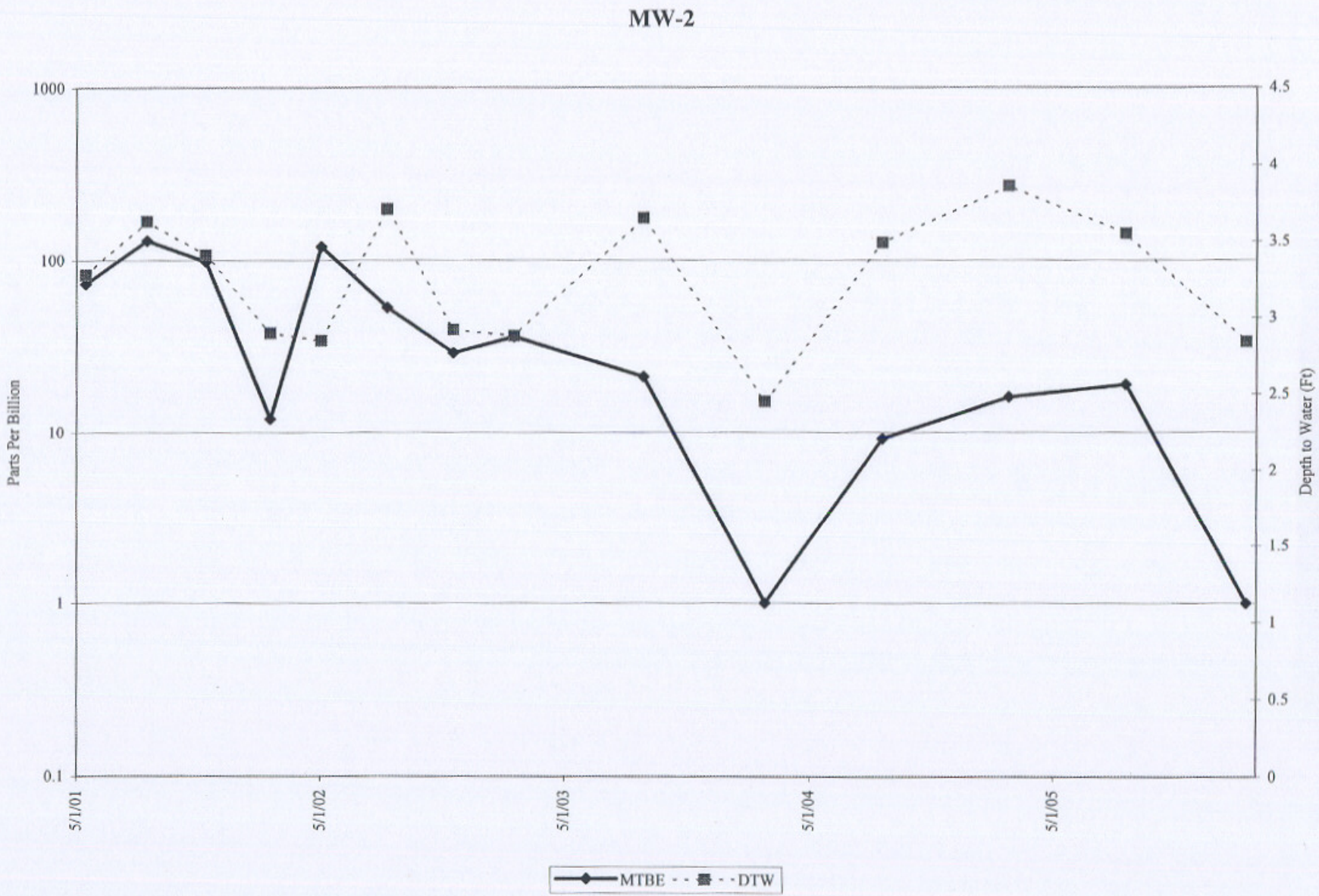
Graph 1. Gasoline and Benzene concentrations vs. time and Depth to Water measurements vs. time in MW-1, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



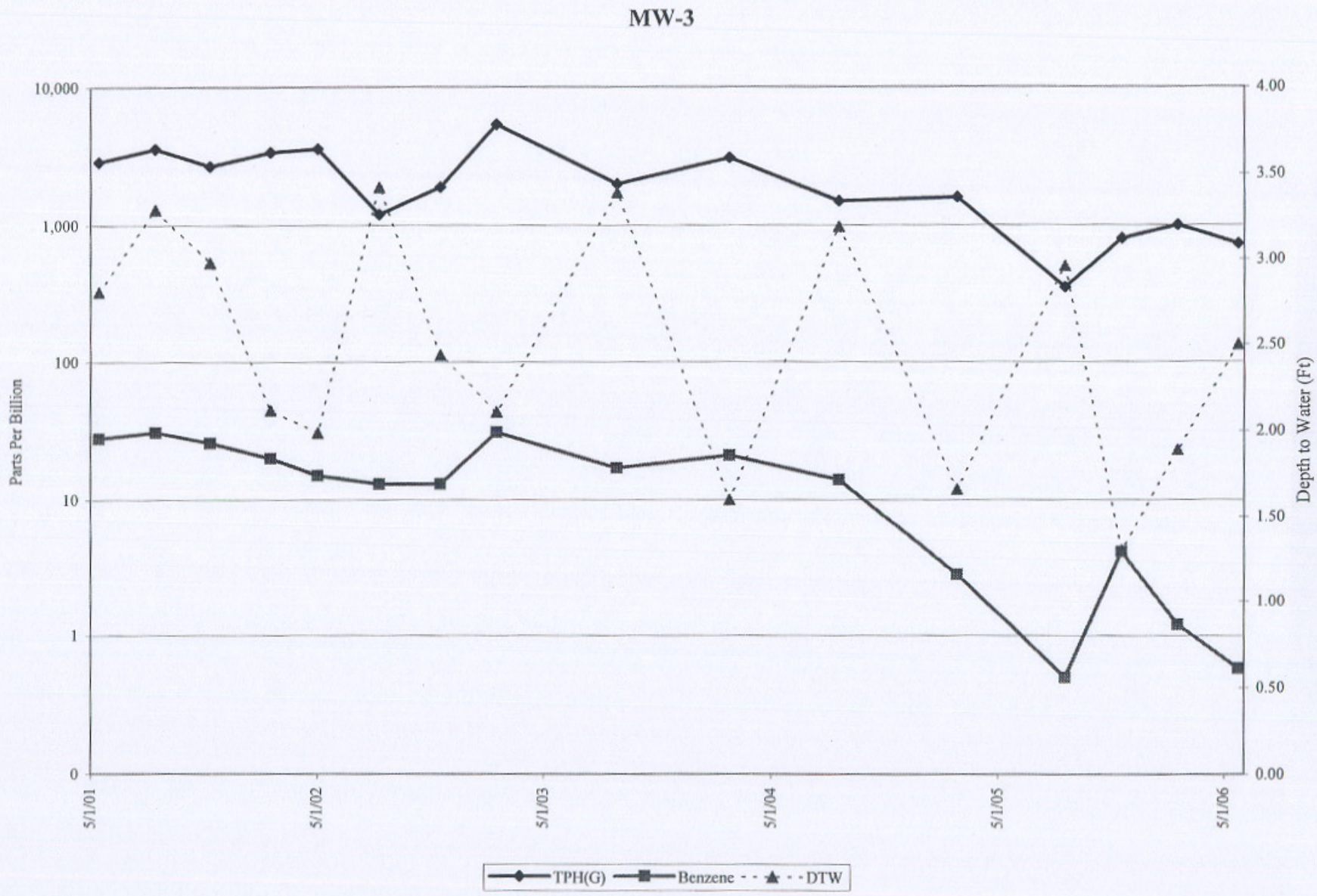
Graph 2. MTBE concentrations vs. time and Depth to Water measurements vs. time in MW-1, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



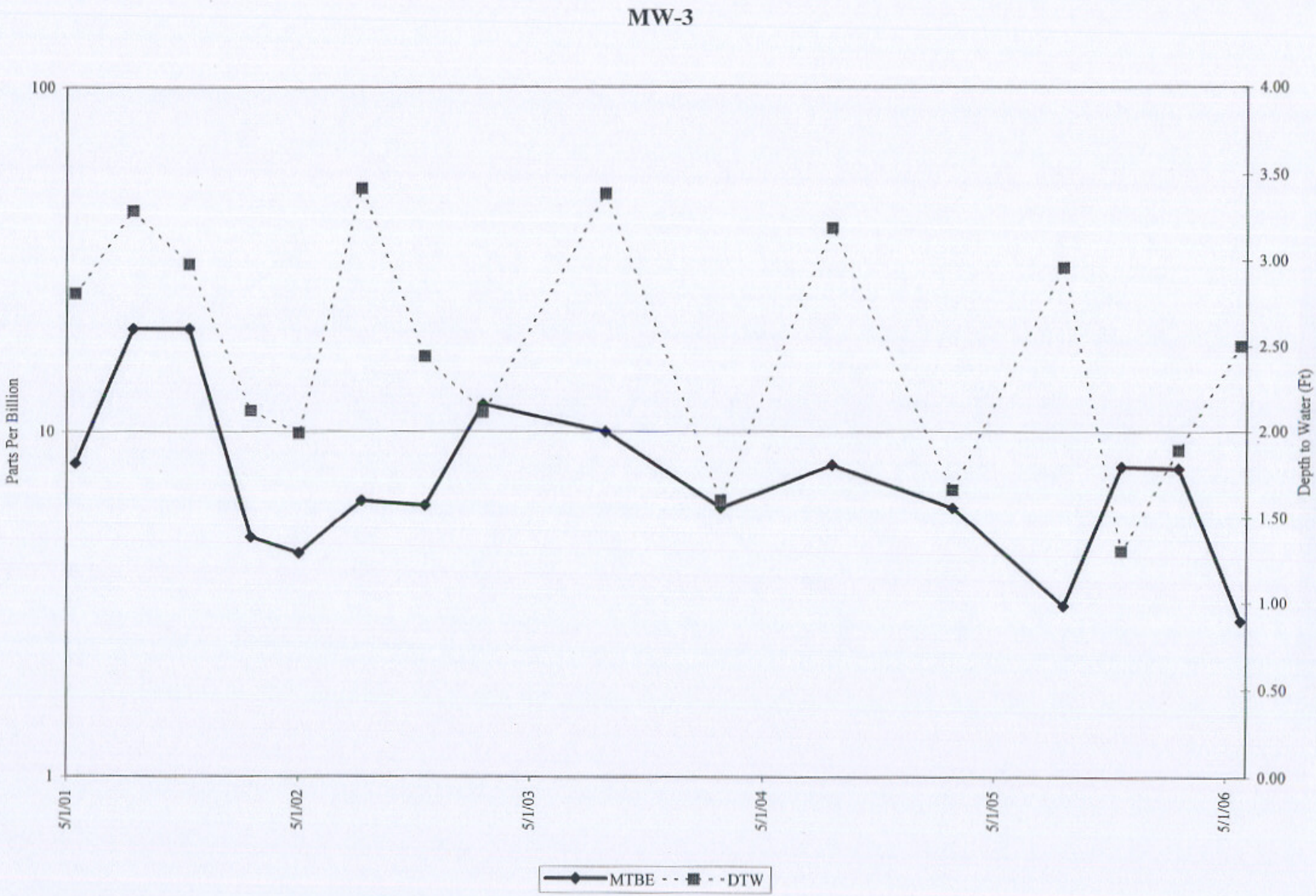
Graph 3. Gasoline and Benzene concentrations vs. time and Depth to Water measurements vs. time in MW-2, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



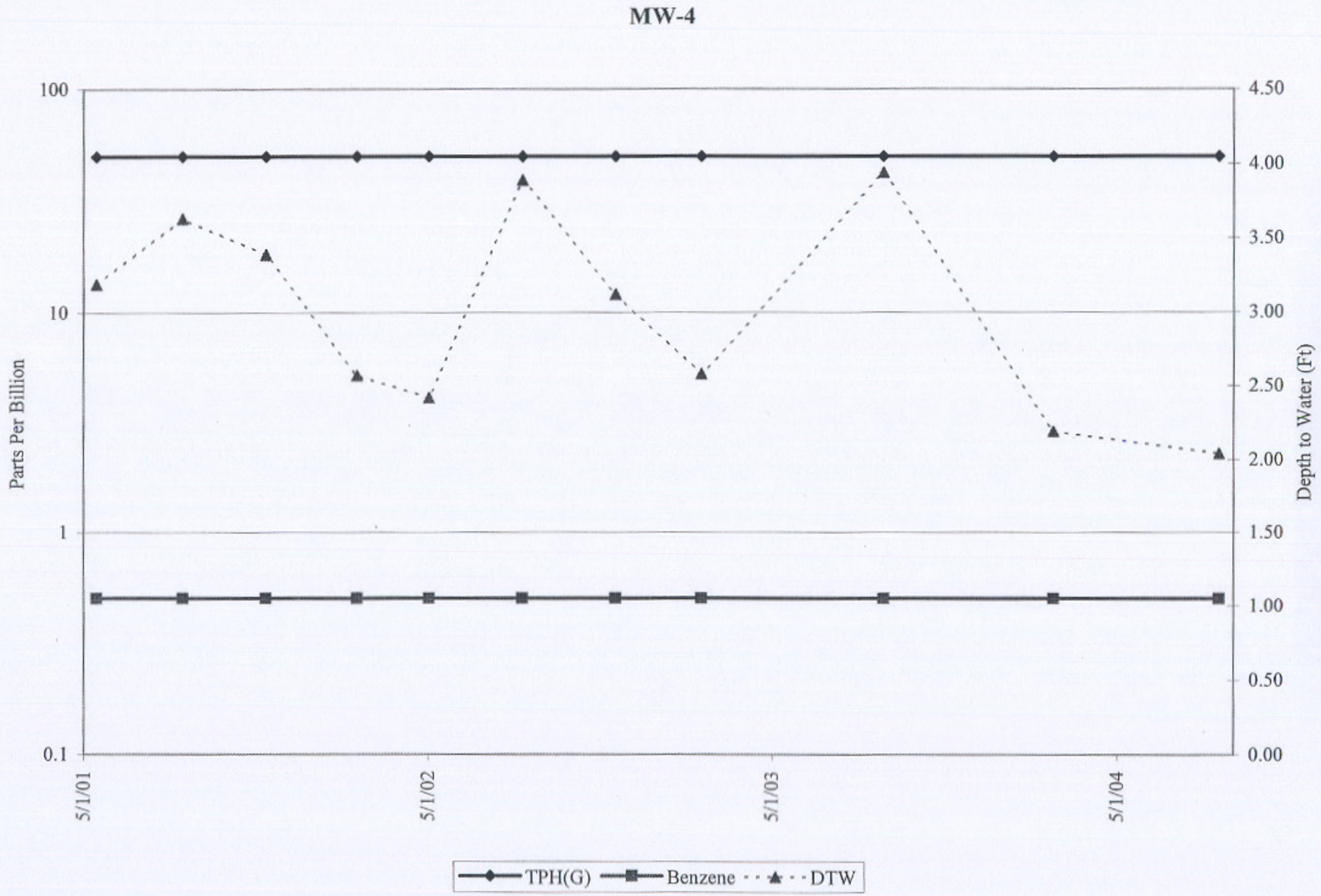
Graph 4. MTBE concentrations vs. time and Depth to Water measurements vs. time in MW-2, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



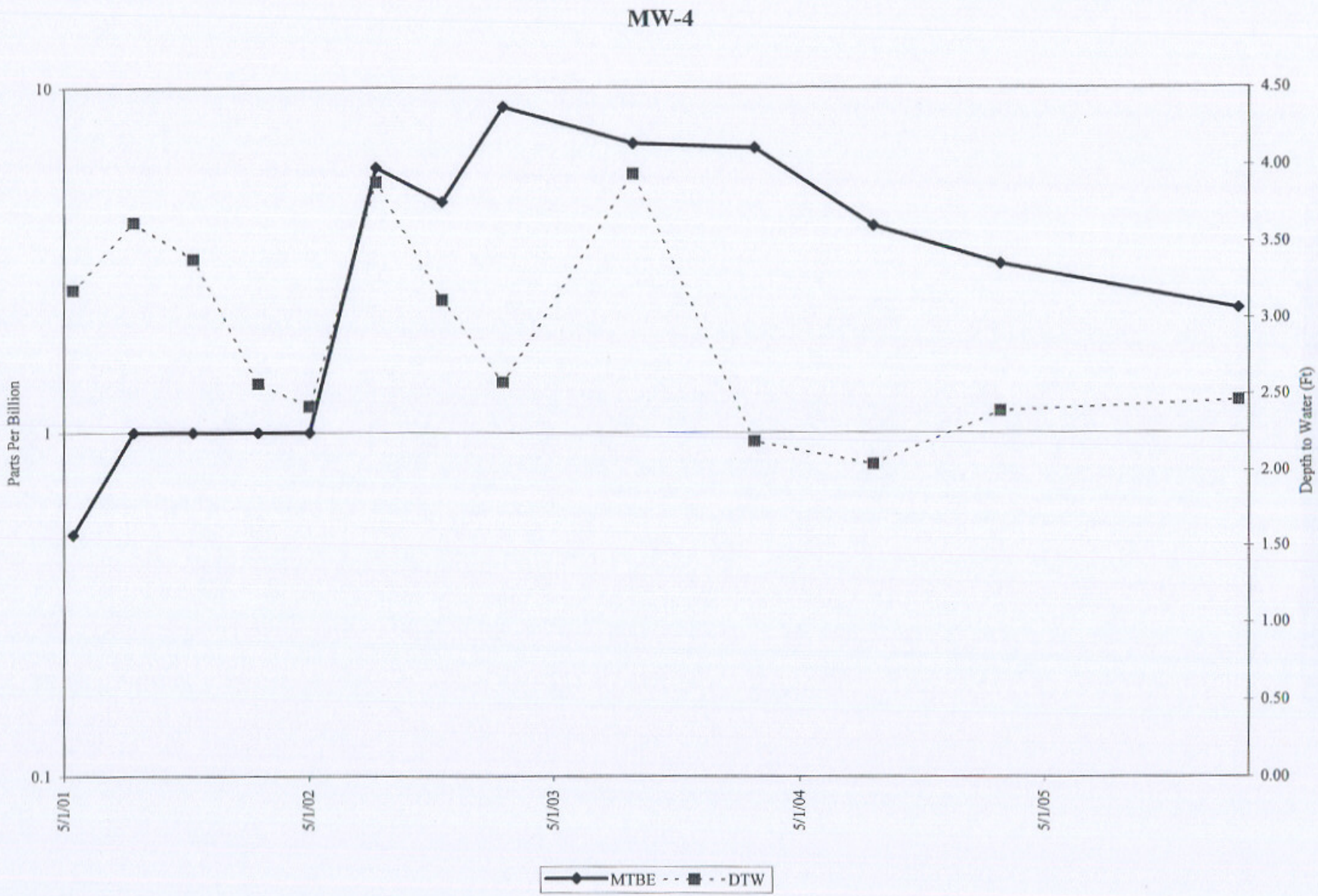
Graph 5. Gasoline and Benzene concentrations vs. time and Depth to Water measurements vs. time in MW-3, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



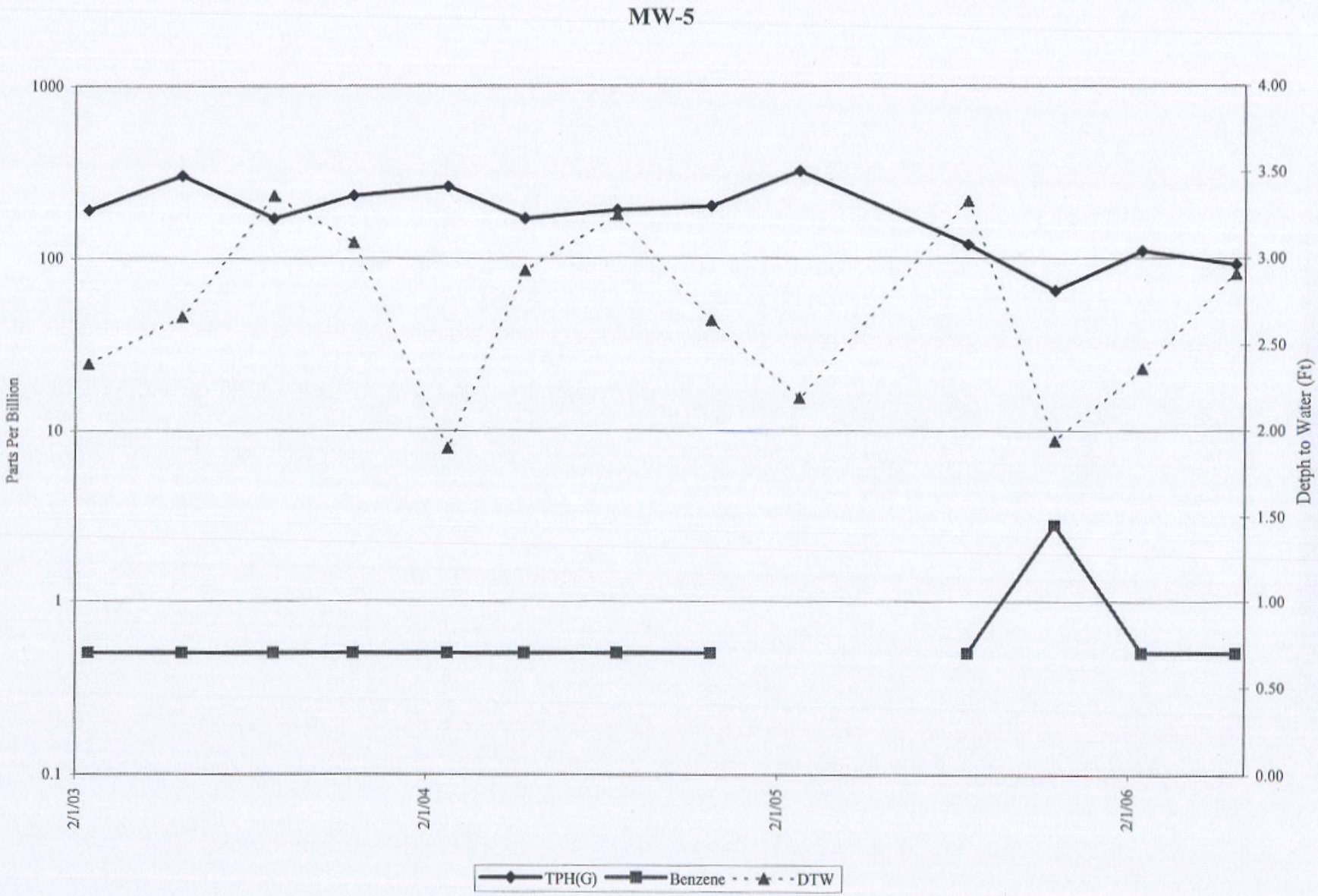
Graph 6. MTBE concentrations vs. time and Depth to Water measurements vs. time in MW-3, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



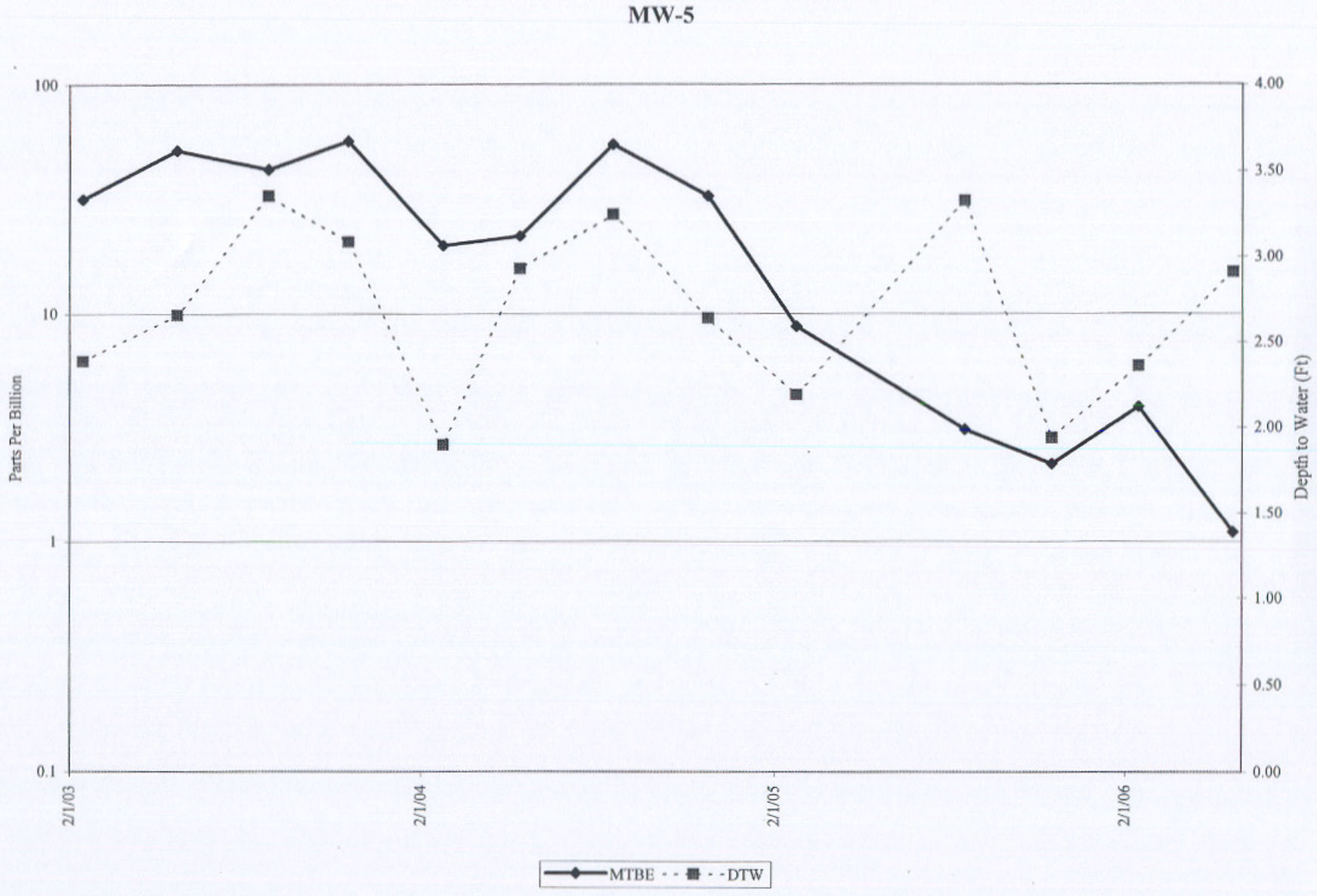
Graph 7. Gasoline and Benzene concentrations vs. time and Depth to Water measurements vs. time in MW-4, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



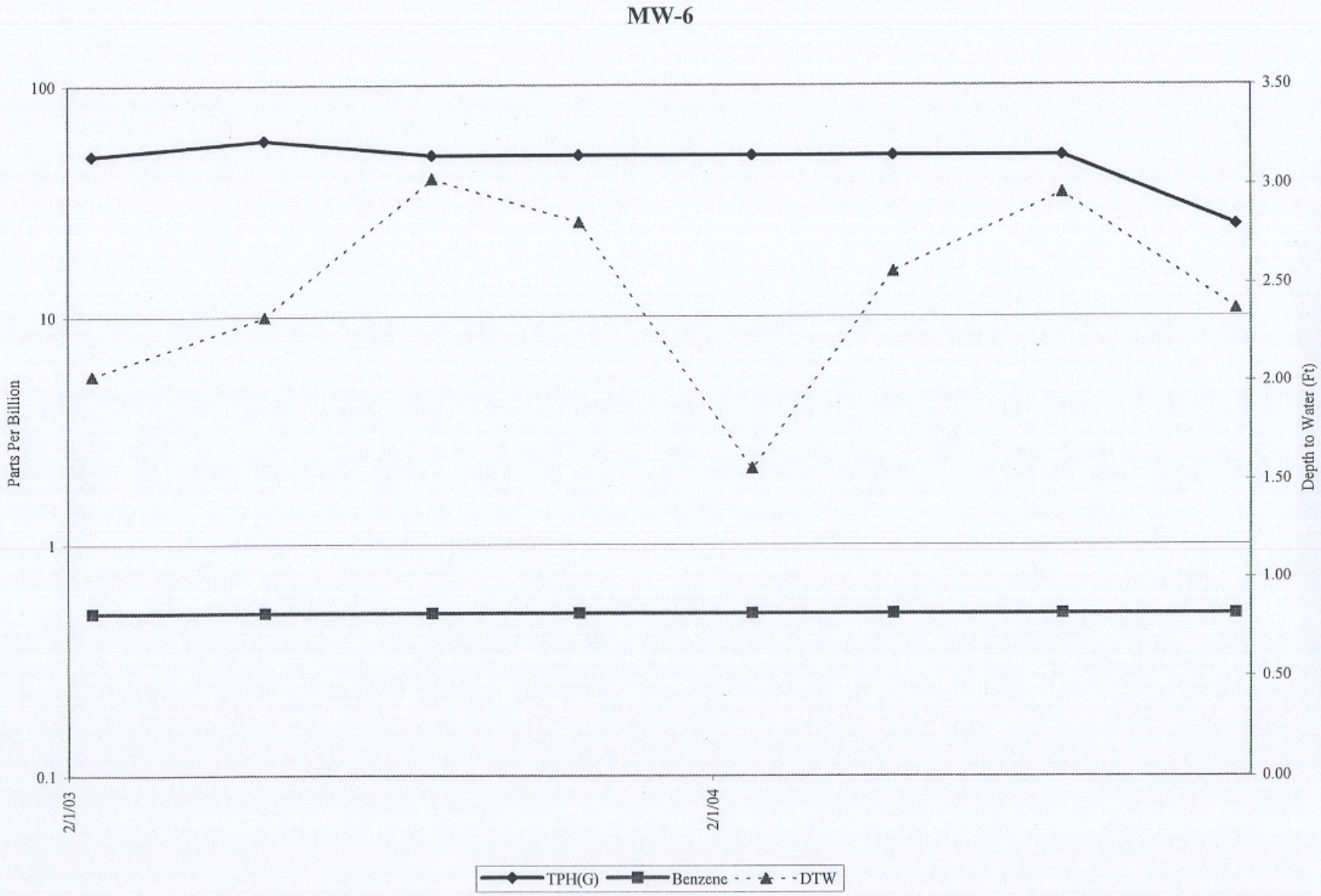
Graph 8. MTBE concentrations vs. time and Depth to Water measurements vs. time in MW-4, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



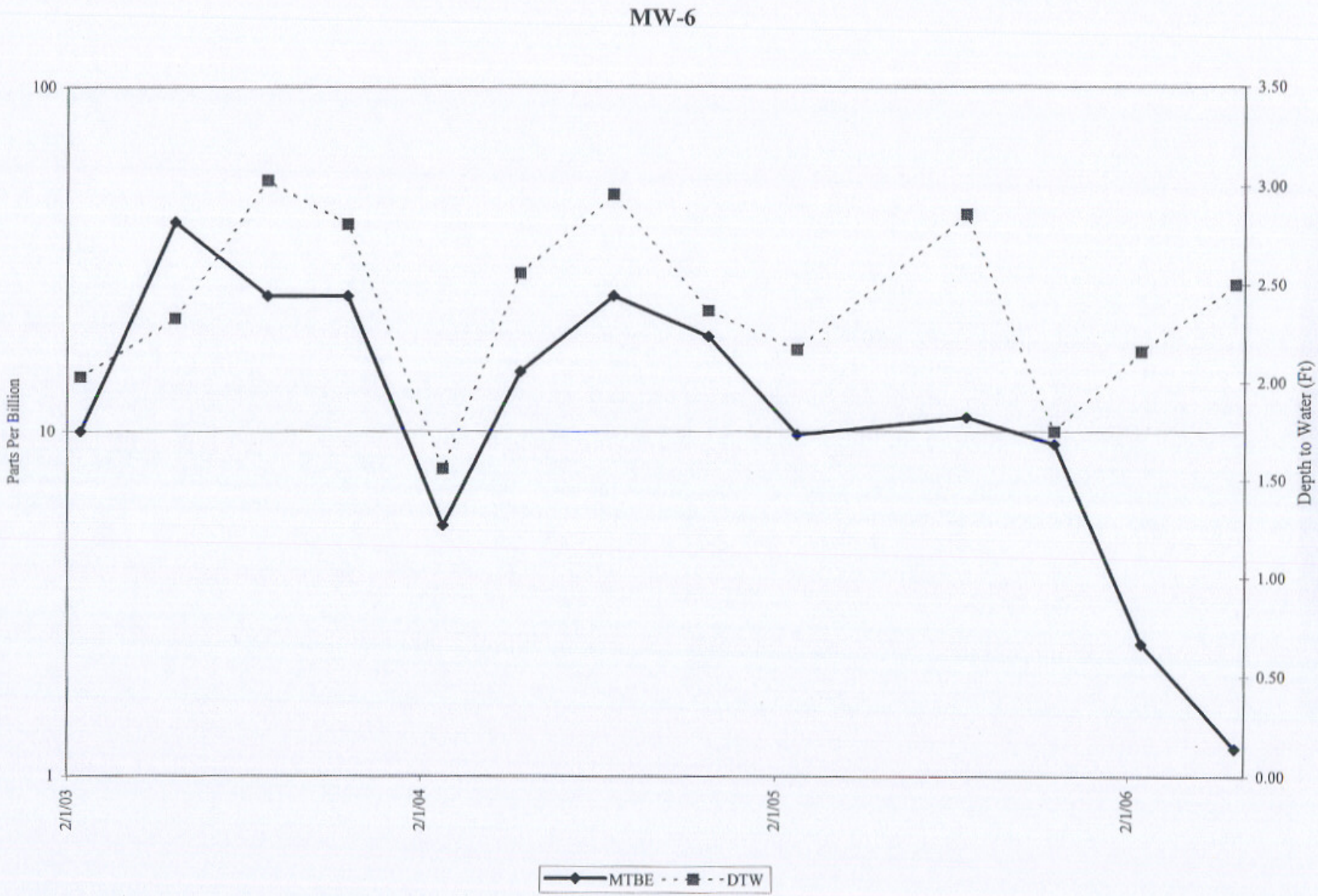
Graph 9. Gasoline and Benzene concentrations vs. time and Depth to Water measurements vs. time in MW-5, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



Graph 10. MTBE concentrations vs. time and Depth to Water measurements vs. time in MW-5, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



Graph 11. Gasoline and Benzene concentrations vs. time and Depth to Water measurements vs. time in MW-6, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.



Graph 12. MTBE concentrations vs. time and Depth to Water measurements vs. time in MW-6, Former Eureka Bulk Plant, 105 X Street, Eureka, CA.

APPENDIX D
FATE AND TRANSPORT MODELING

Fate and Transport Modeling

Fate and transport modeling was performed for benzene and MTBE in order to provide an estimate of time required for natural attenuation to reach the clean-up objectives. The modeling program used was BIOSCREEN. BIOSCREEN is a plume modeling program released by the EPA, which simulates remediation through natural attentuation at petroleum fuel release sites.[8] The software, programmed in the Microsoft Excel spreadsheet environment and based on the Domenico analytical solute transport model, simulates natural processes such as advection, dispersion, adsorption, and aerobic decay as well as anaerobic reactions that have been shown to be the dominant biodegradation processes at many petroleum release sites.

BIOSCREEN Introduction

BIOSCREEN is intended to be used in two ways:

1.) As a screening model to determine if MNA is feasible at a site; and

2.) As the primary RNA groundwater model at smaller sites (i.e. less-complicated sites such as services stations). As such, BIOSCREEN is an appropriate modeling program for the subject site.

BIOSCREEN attempts to answer the following two fundamental questions about MNA:

1.) How far will the dissolved contaminant plume extend if no engineered controls or further source zone reduction measures are implemented?

2.) How long will the plume persist until natural attenuation processes cause it to dissipate?

BIOSCREEN has the following limitations:

1.) As an analytical model, BIOSCREEN assumes simple groundwater flow conditions.

2.) As a screening tool, BIOSCREEN only approximates more complicated processes that occur in the field.

BIOSCREEN provides three different model types:

1.) Solute transport without decay (i.e., no biodegradation).

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8 1997, EPA, BIOSCREEN Natural Attenuation Decision Support System, User's Manual Version 1.4, July 1997

2.) Solute transport with biodegradiation modeled as a first-order decay process. In this approach, all biodegradation mechanisms are lumped as a single parameter (the first-order decay coefficient).

3.) Solute transport with biodegradation modeled as an 'instantaneous' biodegradation reaction.

Model Type 1 (solute transport with no decay) is appropriate for predicting the movement of non-degrading analytes such as chloride. The only attenuation mechanisms are dispersion and adsorption of contaminants to the soil matrix. In the model runs which follow, Model Type 1 is presented for comparison purposes only, to demonstrate transport of analytes in the absence of biodegradation. Model Type 2 (biodegradation modeled as a first-order decay process) is the more commonly used model type. Model Type 3 ('instantaneous' biodegradation model) requires extensive site-specific data which is not available at this site. For this reason, the 'instantaneous' biodegradation model was not used.

Input Parameters

Input parameters are shown on the attached modeling readouts. Reference texts contain typical values for soil and groundwater parameters for various soil types.[9] An explanation of input values follows.

Hydrogeology Values:

Hydraulic conductivity: For the low permeability silts, clays, and silty sands containing relatively high percentages of silts and clays typically encountered at the site, a value of 1×10^{-4} cm/sec was used.

Hydraulic gradient: Values based on historic sampling data. A typical value of 0.006 ft/ft was used.

Porosity: Estimated based on soil type. A typical value of 0.3 was used for all modeling runs.

Seepage velocity: Computed by model based on the above values.

Retardation Factor:

For MTBE, a value of 1.0 was used, meaning no retardation was assumed for MTBE, and that MTBE essentially moves at the speed of groundwater. For BTEX, a typical conservative value of 1.5 was used. Various BTEX constituents can have retardation values, based on soil type, varying from 1.5 to 14.5.[10] The selected values are conservative, assuming a low value for retardation and a correspondingly higher

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9 1989, Basic Ground-Water Hydrology, United States Geological Survey Water-Supply Paper 2220.

10 1999, California State Water Resources Control Board, Draft Guidelines For Investigation and Cleanup of MTBE and Other Ether-Based Oxygenates, December 1, 1999.

mobility for the dissolved constituent in groundwater.

Solute half-life/1st order decay coefficient:

This is the half-life/1st order decay coefficient for the dissolved constituent in the plume. It is not the coefficient for the source. In a first-order reaction model, half-life is related to decay coefficient by the following formula: 1st order decay coefficient = 0.693/half-life. Various published references publish typical values for decay coefficients of various compounds. In practice, half-life/1st order decay coefficient is site-specific and can vary with changing site conditions. For BTEX, a conservative half-life value of 2.0 years was used. For MTBE, a conservative half-life value of 2.0 years was used.[11] Based on existing site data, a more precise value for the half-life/1st order decay coefficient cannot be calculated.

Estimated Source Mass and Extent:

MTBE

Data shows that MTBE concentrations in MW-1 are highest when the groundwater level is between 1.0 and 1.5 ft bgs, indicating a secondary source of MTBE remains in shallow soil near MW-1. Data on MTBE in soil is shown in Table 7 (Appendix B) for excavation data and in Table 9 (Appendix B) for borings and wells. The only MTBE detected in soil at the site was from samples from the 1999 excavation, and one detection during the 2004 excavation (sample 17, at 0.075 ppm). All samples from the 1999 excavation were collected at 1.5 ppm and 2.5 ppm. Average concentration from the 1999 excavation is 0.04 mg/kg. Assuming the entire site (approximately 100 ft x 240 ft) were contaminated with MTBE to a thickness of 2 ft at an average concentration of 0.04 mg/kg, and assuming an average soil weight of 50 kg/ft^3, then the total quantity of MTBE sorbed to soil would be about 0.1 kg. The actual quantity of MTBE-containing soil is assumed to be no greater than ten percent of this amount, for an estimated mass of 0.01 kg MTBE.

Benzene:

The only detection of benzene in soil located outside the excavated zone was collected from MW-3 (0.066 mg/kg at 4 ft bgs). MW-3 is also the well with the highest average concentration of benzene. Assuming this sample result represents a remaining area (after the excavation) approximately 15 ft x 30 ft and a thickness of approximately 4 ft, and assuming an average soil weight of 50 kg/ft^3, then the mass of benzene in soil would be about 6 grams.

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11 2002, Role of Natural Attenuation in Life Cycle of MTBE Plumes, John T. Wilson and Ravi Kolhatkar, Journal of Environmental Engineering, September 2002.

Initial Groundwater Concentration in Source Zone

For MTBE, the average concentration was considered to be the average from the last 4 sampling events for MW-1, or approximately 50 ppb. For benzene, the average concentration was considered to the average from the last 4 sampling events for MW-3, or about 2 ppb.

MTBE Modeling Results

Modeling results for MTBE are shown on the attached print-outs (Model Display 1). A center-line graph of predicted plume concentrations vs. distance is shown for MTBE, assuming the input parameters discussed above, after intervals of 20, 40, 60, and 130 years. The graphs show predicted results given 1st order decay, and, for comparison purposes, assuming no biodegradation. The model predicts the following:

1.) At no point will the plume extend more than 160 ft past the point of origin.

2.) The concentration is predicted to be a maximum of 6 ppb at a distance of 80 ft from the point of origin.

3.) The clean-up goal of 5 ppb is predicted at 80 ft from the point of origin after 60 years. At that time, the concentration at the point of origin is predicted to be 17 ppb.

4.) The clean-up goal of 5 ppb is predicted to be reached at the point of origin after 130 years.

The accuracy of the model's prediction of time required to attain clean-up goals is limited by the accuracy of the source mass estimate. If the source mass is greater than estimated, the time required to attain the clean-up goal will be greater, and if the source mass is less than estimated, the time required to attain the clean-up goal will be shorter. The accuracy of the models prediction of the distance the plume will travel is limited by the accuracy of the estimate of the hydraulic conductivity. In reality, hydraulic conductivity value can vary significantly across a site.

Benzene Modeling Results

Modeling results for benzene are shown on the attached print-outs (Model Display 2). A center-line graph of predicted plume concentrations vs. distance is shown for benzene, assuming the input parameters discussed above, after intervals of 20, 40, 60, and 100 years. The graphs show predicted results given 1st order decay, and, for comparison purposes, assuming no biodegradation. The model

predicts the following:

1.) No significant migration away from the source zone is predicted for benzene. At no point are detectable concentrations of benzene predicted at a distance of greater than 80 ft form the source.

2.) Very low concentrations of benzene (on the order of 2 ppb) are predicted to be present in a limited area near the source for an indefinite period of time.

Model Display 1.) MTBE Input Parameter Screen, Eureka Bulk Plant, 105 x St., Eureka, CA

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

105 X St Eureka
MTBE
Run Name

Data Input Instructions:

115
↑ or
0.02

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

Variable* — *Data used directly in model.*
20 — *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	Vs	2.1	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	1.0E-04	(cm/sec)
Hydraulic Gradient	i	0.006	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity	alpha x	13.8	(ft)
Transverse Dispersivity*	alpha y	1.4	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		↑ or	
Estimated Plume Length	Lp	300	(ft)

3. ADSORPTION

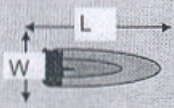
Retardation Factor*	R	1.0	(-)
or		↑ or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	6.9E-2	(per yr)
or		↑ or	
Solute Half-Life	t-half	10.00	(year)
or Instantaneous Reaction Mode			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	800	(ft)
Modeled Area Width*	200	(ft)
Simulation Time*	20	(yr)



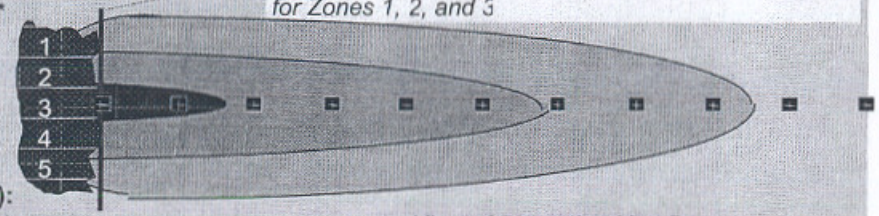
6. SOURCE DATA

Source Thickness in Sat.Zone* 2 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
100	0.05
0	0
0	0

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

40	40 (yr)
Inst. React.	↑ 1st Order

Soluble Mass In Source NAPL, Soil: 0 (Kg)

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	
80	
160	
240	
320	
400	
480	
560	
640	
720	
800	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

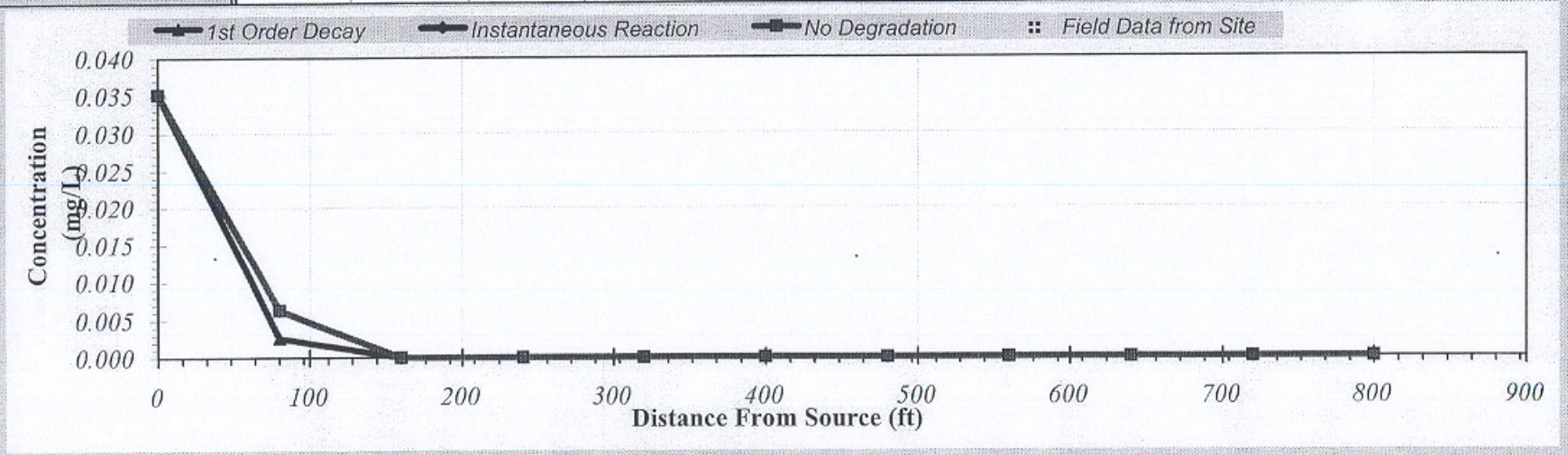
Restore Formulas for Vs, Dispersivities, R, lambda, other

Model Display 1.a.) MTBE, 20 Years, Eureka Bulk Plant, 105 X St. Eureka, CA

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.035	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.035	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.035	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation
Next Timestep
Prev Timestep

Time:
20 Years

Return to Input

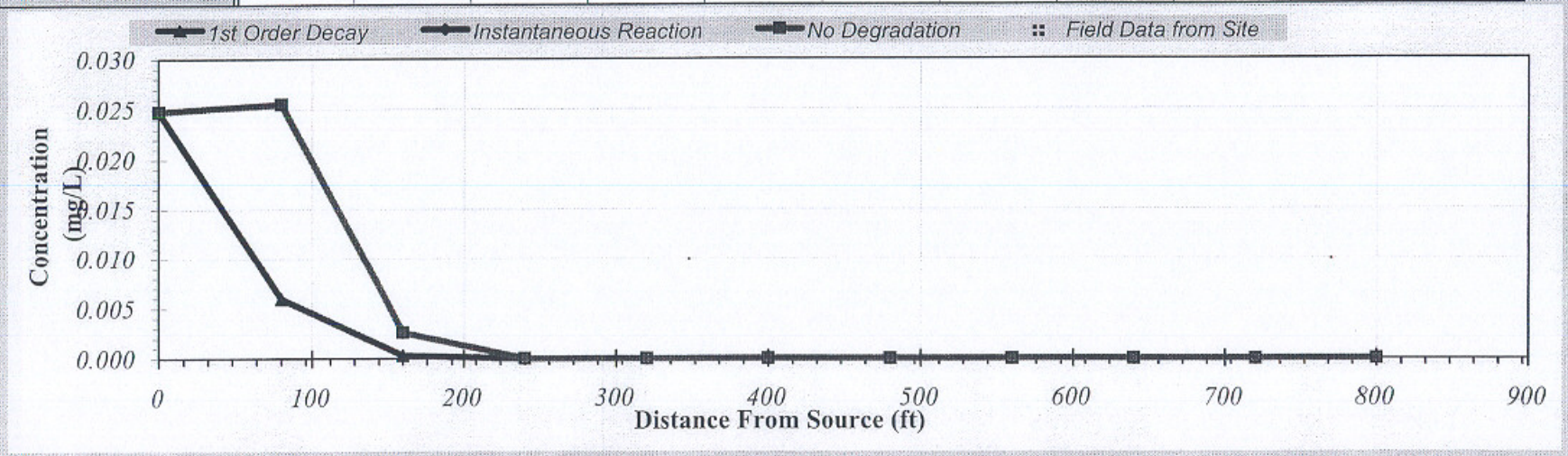
Recalculate This Sheet

Model Display 1.b.) MTBE, 40 Years, Eureka Bulk Plant, 105 X St. Eureka, CA

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.025	0.026	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.025	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.025	0.026	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation
Next Timestep
Prev Timestep

Time:
40 Years

Return to Input

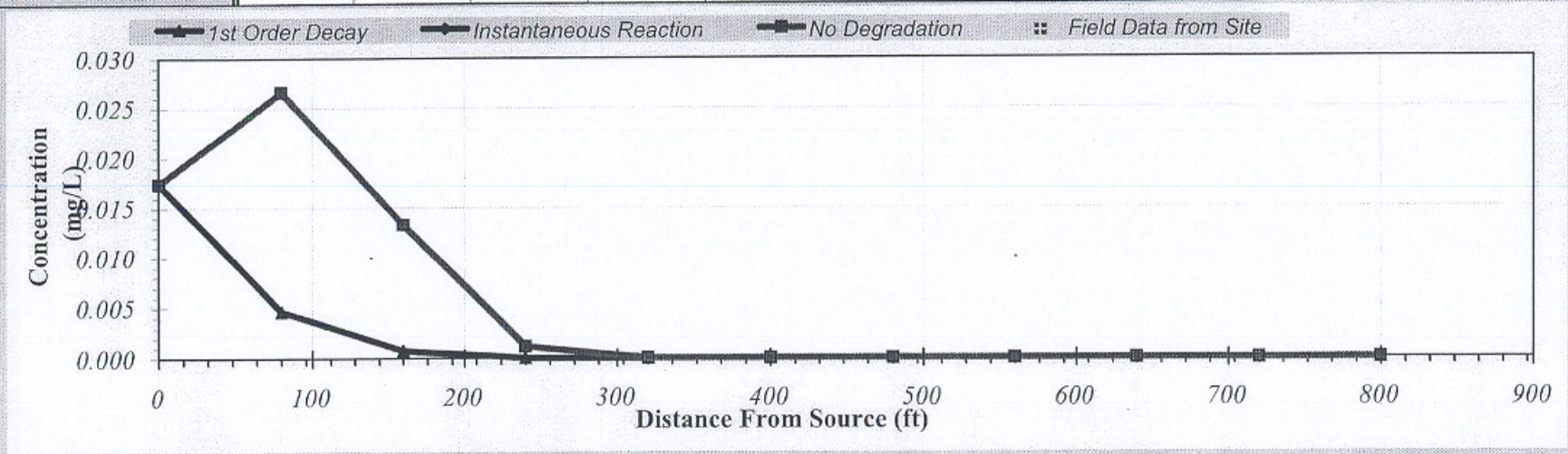
Recalculate This Sheet

Model Display 1.c.) MTBE, 60 Years, Eureka Bulk Plant, 105 X St. Eureka, CA

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.017	0.027	0.013	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.017	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.017	0.027	0.013	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation
Next Timestep
Prev Timestep

Time:
60 Years

Return to Input

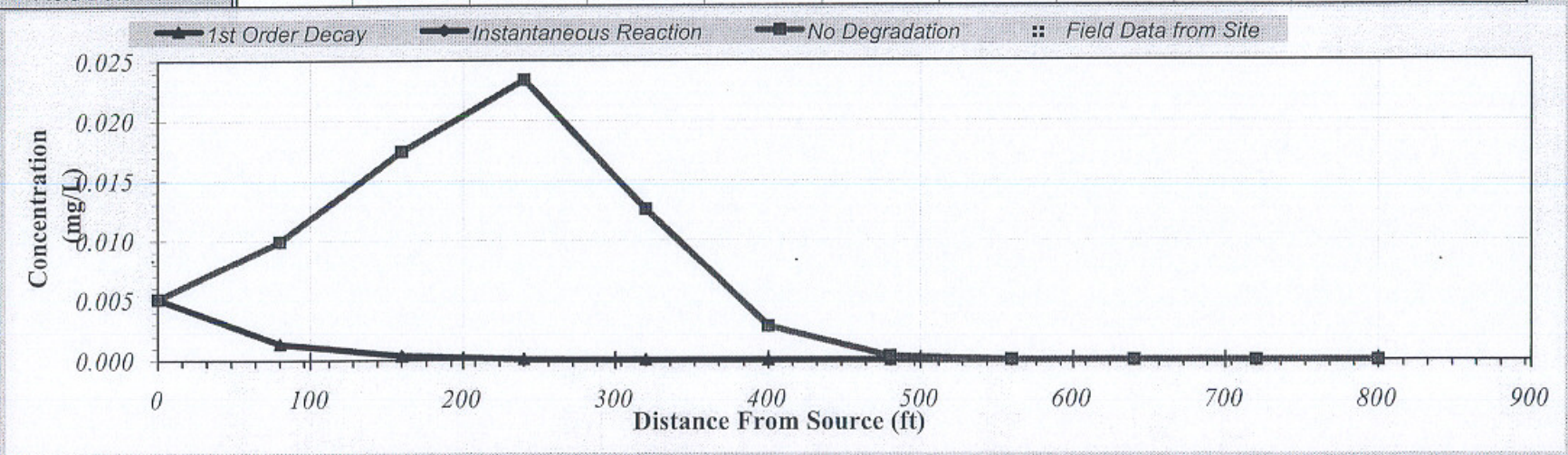
Recalculate This Sheet

Model Display 1.d.) MTBE, 130 Years, Eureka Bulk Plant, 105 X St. Eureka, CA

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.005	0.010	0.017	0.023	0.013	0.003	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.005	0.010	0.017	0.023	0.013	0.003	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Next Timestep

Prev Timestep

Time: 130 Years

Return to Input

Recalculate This Sheet

Model Display 2.) Benzene Input Parameter Screen, Eureka Buk Plant, 105 X St., Eurica, CA

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

105 X St Eureka / Benzene — *Run Name*

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

115 ↑ or 0.02

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	2.1	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	1.0E-04	(cm/sec)
Hydraulic Gradient	i	0.006	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity	alpha x	13.8	(ft)
Transverse Dispersivity*	alpha y	1.4	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		↑ or	
Estimated Plume Length	Lp	300	(ft)

3. ADSORPTION

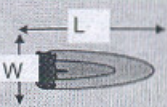
Retardation Factor*	R	1.6	(-)
or		↑ or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.5E-1	(per yr)
or		↑ or	
Solute Half-Life	t-half	2.00	(year)
or Instantaneous Reaction Mode			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	800	(ft)
Modeled Area Width*	200	(ft)
Simulation Time*	20	(yr)



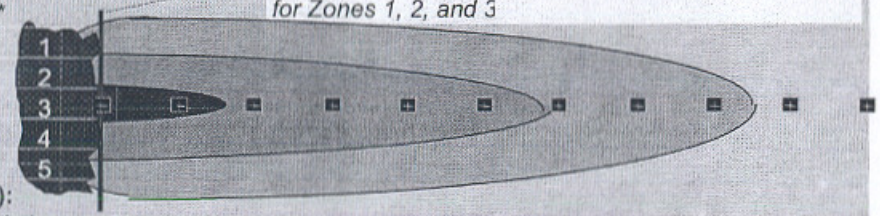
6. SOURCE DATA

Source Thickness in Sat.Zone* 2 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
100	0.002
0	0
0	0

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

600	600 (yr)
Inst. React.	↑ 1st Order
Soluble Mass	0 (Kg)

In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	0	80	160	240	320	400	480	560	640	720	800
Concentration (mg/L)											

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

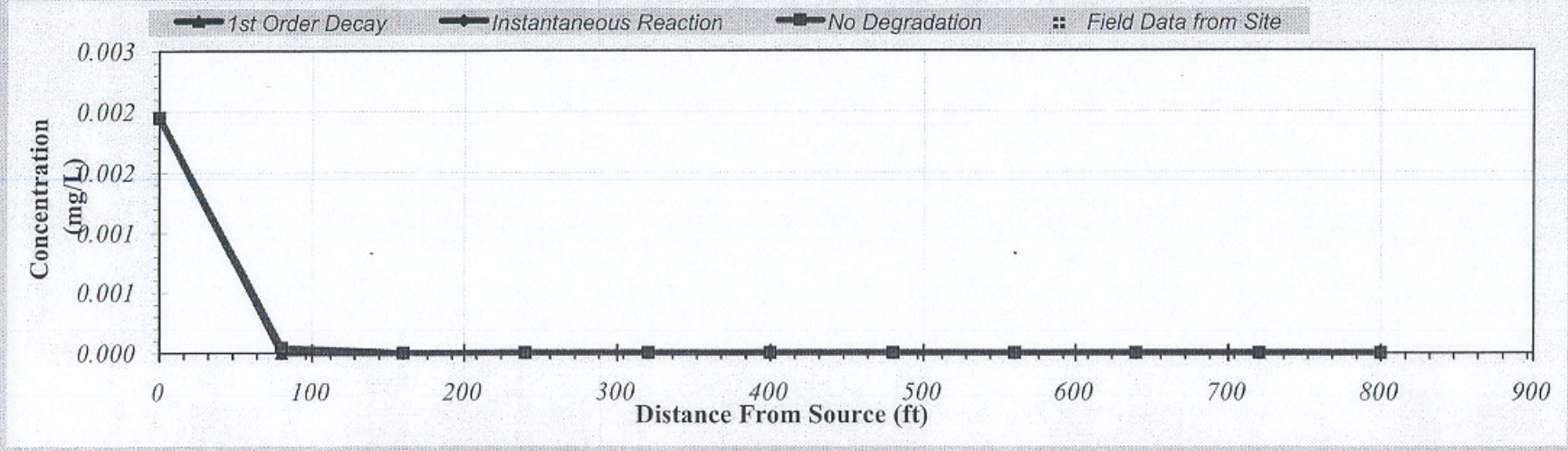
Restore Formulas for Vs, Dispersivities, R, lambda, other

Model Display 2.a.) Benzene, 20 Years, Eureka Bulk Plant, 105 X St., Eureka, CA

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Next Timestep

Prev Timestep

Time: 20 Years

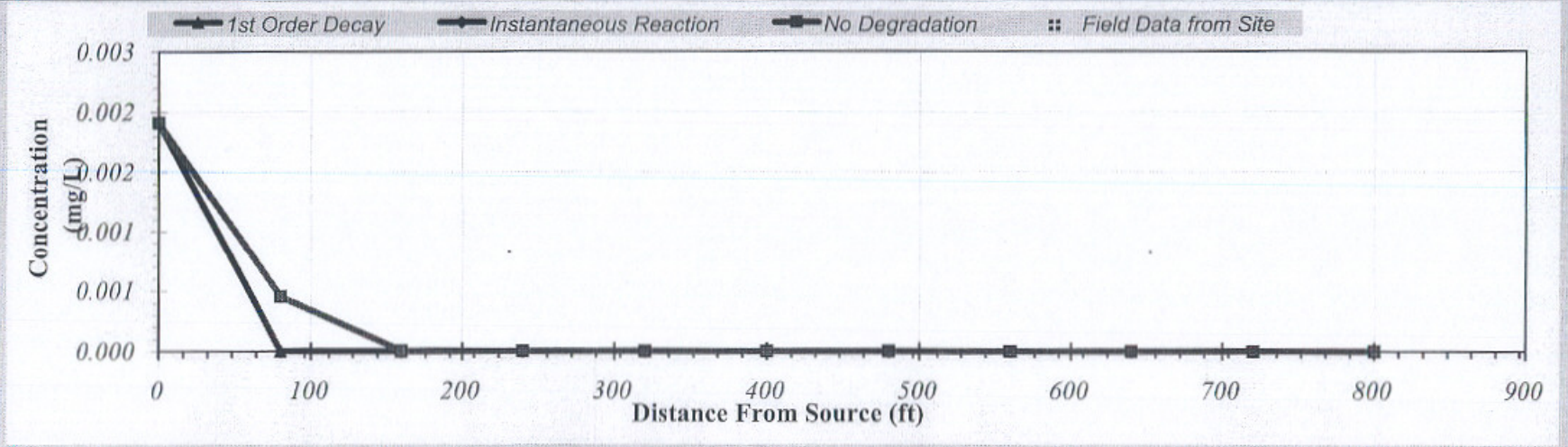
Return to Input

Recalculate This Sheet

Model Display 2.b.) Benzene, 40 Years, Eureka Bulk Plant, 105 X St., Eureka, CA

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation
Next Timestep
Prev Timestep

Time:
40 Years

Return to Input

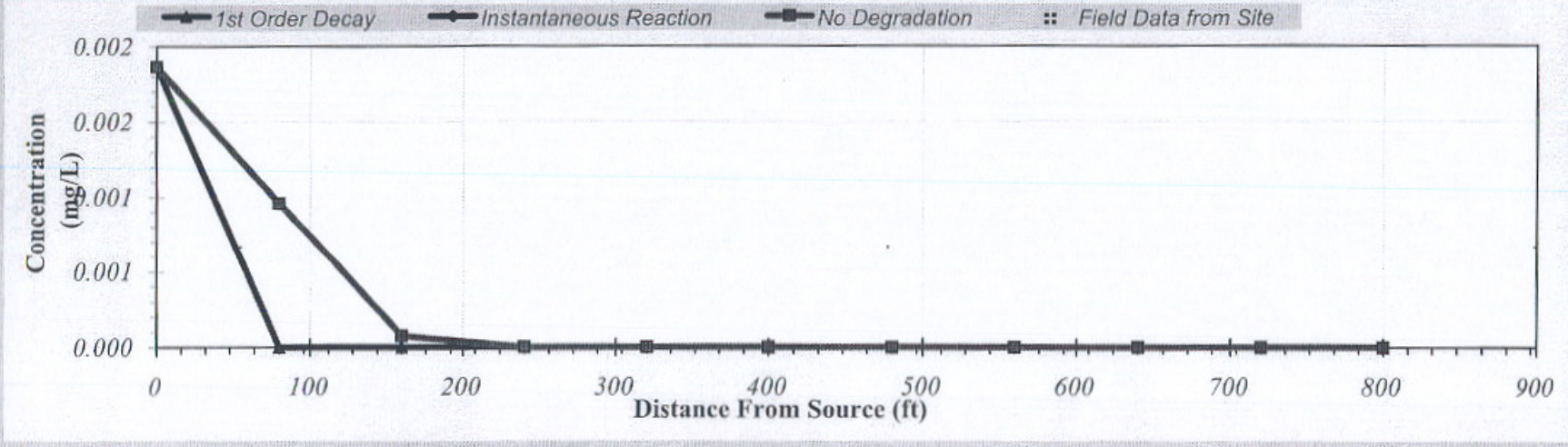
Recalculate This Sheet

Model Display 2.c.) Benzene, 60 Years, Eureka Bulk Plant, 105 X St., Eureka, CA

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation

Next Timestep

Prev Timestep

Time:

60 Years

Return to Input

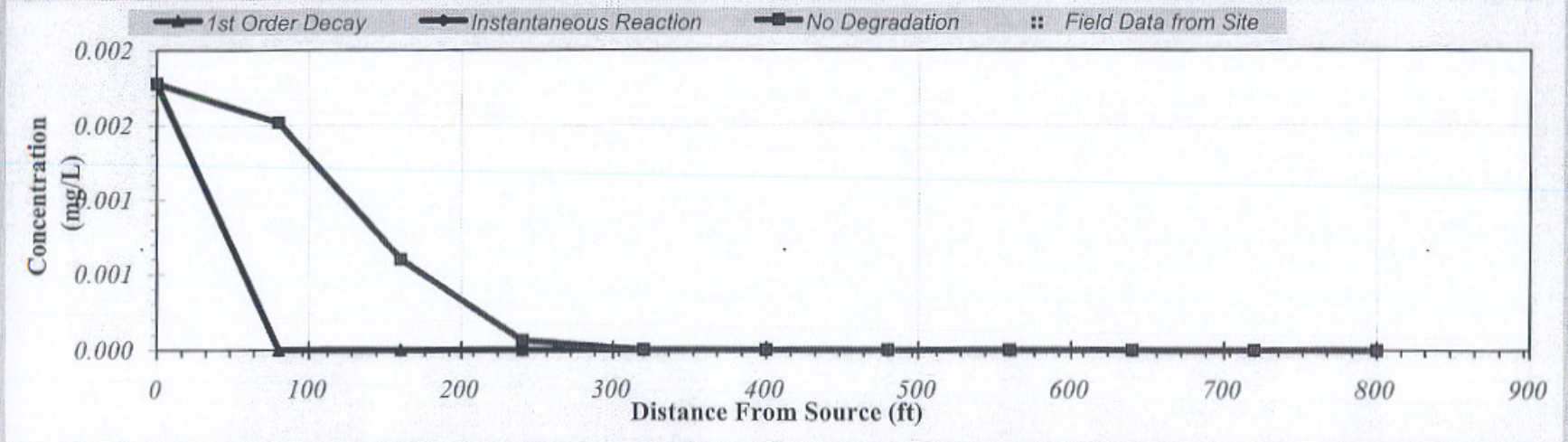
Recalculate This Sheet

Model Display 2.d.) Benzene, 100 Years, Eureka Bulk Plant, 105 X St., Eureka, CA

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	0.002	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.002	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Calculate Animation
Next Timestep
Prev Timestep

Time:
100 Years

Return to Input

Recalculate This Sheet